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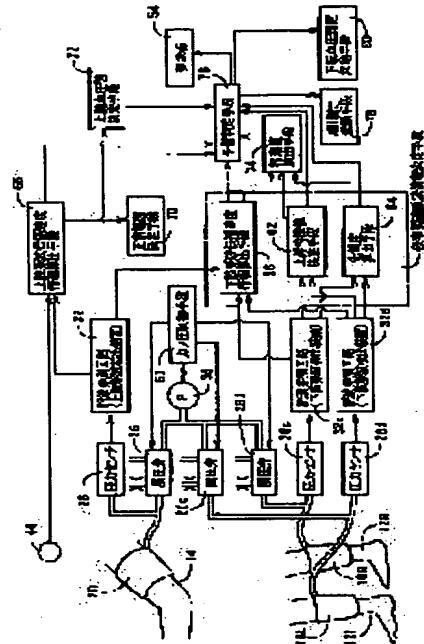
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(54) ANKLE-BRACHIAL BLOOD PRESSURE INDEX MEASURING APPARATUS

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an ankle-brachial blood pressure index measuring apparatus causing less pain to a patient in diagnosing an ankle artery for constriction.

SOLUTION: Before the pressure of an ankle cuff 18 is built up, for the measurement of blood pressure, to a pressure higher than the highest blood pressure value, the pressure of the ankle cuff 18 is built up to 60 mmHg and an ankle pulse wave WLL is detected. An ankle pulse wave propagation velocity information calculating means 68 calculates the propagation velocity baPWV of the ankle pulse wave on the basis of the ankle pulse wave WLL and a rise feature value determining means 62 calculates U-time. A sharpness calculating means 64 calculates %MAP, and using the baPWV, U-time, and %MAP a preliminary determination means 76 makes a preliminary determination as to whether or not the ankle artery is constricted. If the determination made by the preliminary determination means 76 shows no sign of constriction, then the need to measure the ankle blood pressure value using the ankle cuff 18 is eliminated, so the patient's pain is reduced.



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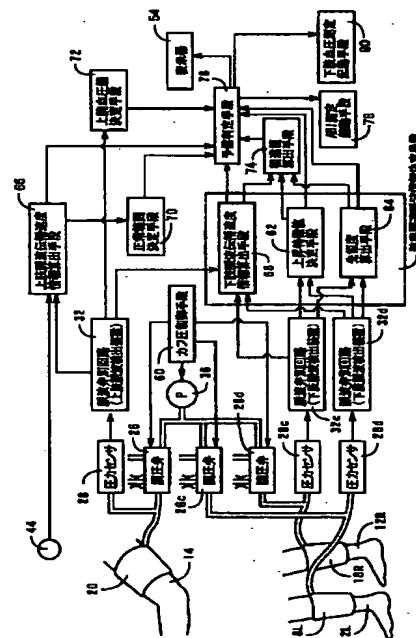
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(54)【発明の名称】 下肢上肢血圧指數測定装置

(57)【要約】

【目的】 下肢動脈の狭窄を診断する際の患者の苦痛が少ない下肢上肢血圧指數測定装置を提供する。

【解決手段】 血圧測定のために足首用カフ18を最高血圧値よりも高い圧力まで昇圧する前に、その足首用カフ18を60mmHgまで昇圧して足首脈波WL_Lを検出する。そして、その足首脈波WL_Lに基づいて、下肢脈波伝播速度情報算出手段6-8により下肢脈波伝播速度baPWVを算出し、上昇特徴値決定手段6-2によりU-time_{ee}を算出し、先鋭度算出手段6-4により%MAPを算出し、予備判定手段7-6によりそれらbaPWV, U-time_{ee}, %MAPを用いて下肢動脈に狭窄の疑いがあるか否かの予備判定を行う。その予備判定手段7-6による判定により狭窄の疑いがないと判定できれば足首用カフ18を用いて足首血圧値を測定する必要がなくなるので、患者の苦痛が少なくなる。



【特許請求の範囲】

【請求項1】 生体の下肢に巻回されるカフを用いて該下肢における血圧値である下肢血圧値を測定する下肢血圧測定装置と、該生体の上肢に巻回されるカフを用いて該上肢における血圧値である上肢血圧値を測定する上肢血圧測定装置と、該下肢血圧測定装置により測定された下肢血圧値と該上肢血圧測定装置により測定された上肢血圧値とに基づいて、下肢上肢血圧指数を算出する下肢上肢血圧指数算出手段とを備えた下肢上肢血圧指数測定装置であって、

該生体の下肢に装着されて下肢脈波を検出する下肢脈波検出装置と、

前記下肢脈波検出装置により検出された下肢脈波に基づいて、下肢の狭窄に関連して変動する狭窄関連脈波情報を決定する狭窄関連脈波情報決定手段とを含むことを特徴とする下肢上肢血圧指数測定装置。

【請求項2】 前記狭窄関連脈波情報決定手段により決定された狭窄関連脈波情報が、予め設定された異常範囲内の値であることに基づいて下肢動脈に狭窄の疑いがあると判定する予備判定手段と、該予備判定手段により狭窄の疑いがあると判定された場合には、前記下肢血圧測定装置および前記上肢血圧測定装置により血圧測定を実行させる血圧測定起動手段とをさらに含むことを特徴とする請求項1に記載の下肢上肢血圧指数測定装置。

【請求項3】 前記狭窄関連脈波情報決定手段として、次の3つの手段のうち、少なくとも1つを含むことを特徴とする請求項1または2に記載の下肢上肢血圧指数測定装置。

(1)前記下肢脈波検出装置により検出される下肢脈波に基づいて、前記下肢を脈波が伝播する速度に関連する下肢脈波伝播速度情報を算出する下肢脈波伝播速度情報算出手段

(2)前記下肢脈波検出装置により検出される下肢脈波の先鋭度を算出する先鋭度算出手段

(3)前記下肢脈波検出装置により検出される下肢脈波の上昇部分の特徴値である上昇特徴値を決定する上昇特徴値決定手段

【請求項4】 前記狭窄関連脈波情報算出手段として、前記下肢脈波検出装置により検出される下肢脈波に基づいて、前記下肢を脈波が伝播する速度に関連する下肢脈波伝播速度情報を算出する下肢脈波伝播速度情報算出手段を含む請求項1または2に記載の下肢上肢血圧指数測定装置であって、前記生体の上肢に装着されて上肢脈波を検出する上肢脈波検出装置と、

該上肢脈波検出装置により検出された上肢脈波に基づいて、前記上肢を脈波が伝播する速度に関連する上肢脈波伝播速度情報を算出する上肢脈波伝播速度情報算出手段と、

該上肢脈波伝播速度情報算出手段により算出される上肢脈波伝播速度情報に基づいて、予め記憶された関係から下肢脈波伝播速度情報の正常範囲を決定する正常範囲決定手段と、

前記下肢脈波伝播速度情報算出手段により算出された下肢脈波伝播速度情報が、前記正常範囲決定手段により決定された正常範囲外であることに基づいて、下肢動脈に狭窄の疑いがあると判定する予備判定手段とをさらに含むことを特徴とする下肢上肢血圧指数測定装置。

【請求項5】 請求項1または2に記載の下肢上肢血圧指数測定装置であって、

前記下肢脈波検出装置は、前記生体の左右の下肢にそれぞれ装着されており、

前記狭窄関連脈波情報を決定手段は、左下肢脈波および右下肢脈波に基づいて前記狭窄関連脈波情報をそれぞれ決定するものであることを特徴とする下肢上肢血圧指数測定装置。

【請求項6】 前記狭窄関連脈波情報を決定手段においてそれぞれ決定された左下肢脈波に基づく狭窄関連脈波情報と右下肢脈波に基づく狭窄関連脈波情報との相違値が予め設定された基準値以上である場合には、下肢動脈に狭窄の疑いがあると判定する予備判定手段を含むことを特徴とする請求項5に記載の下肢上肢血圧指数測定装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、下肢上肢血圧指数を測定する下肢上肢血圧指数測定装置に関するものである。

【0002】

【従来の技術】 通常、下肢における血圧値（以下、下肢血圧値という）は上肢における血圧値（以下、上肢血圧値という）よりも高い。しかし、下肢の動脈に狭窄があると、下肢血圧値は上肢血圧値よりも低くなる。このことを利用して下肢動脈の狭窄を診断するために、下肢血圧値と上肢血圧値との比である下肢上肢血圧指数を算出する下肢上肢血圧指数測定装置が提案されている。たとえば、特許第3027750号公報に記載された装置がそれである。

【0003】 下肢上肢血圧指数を算出するためには、下肢血圧値および上肢血圧値を測定しなければならない。下肢血圧値および上肢血圧値を測定するためには、カフを生体の下肢または上肢に巻回し、そのカフの圧迫圧力を徐速変化させる過程でカフに発生する信号に基づいて血圧値を測定する形式の血圧測定装置が一般に使用される。カフを用いる形式の血圧測定装置は信頼性の高い血圧値が得られるからである。カフを用いて測定された下肢血圧値および上肢血圧値に基づいて算出される下肢上肢血圧指数は信頼性が高く、精度よく下肢動脈の狭窄が診断できる。

【0004】

【発明が解決しようとする課題】しかし、カフを用いる形式の血圧測定装置により血圧値を測定する場合には、カフの圧迫圧力を、一旦、最高血圧値よりも高い圧力に設定された目標圧力まで昇圧する必要がある。また、正常な者であれば、下肢における最高血圧値は上肢における最高血圧値よりも高いので、下肢血圧値を測定する場合には、上肢血圧値を測定する場合よりもさらに高い目標圧力までカフの圧迫圧力を昇圧する必要がある。たとえば、上肢血圧測定装置では、目標圧力は180mmHg程度が一般的であるのに対し、下肢血圧測定装置では、目標圧力は240mmHg程度に設定される。そのため、下肢血圧値を測定する際に患者に与える苦痛が比較的大きいという問題があった。

【0005】本発明は以上の事情を背景として為されたもので、その目的とするところは、下肢動脈の狭窄を診断する際の患者の苦痛が少ない下肢上肢血圧指數測定装置を提供することにある。

【0006】

【課題を解決するための手段】本発明者は、上記目的を達成するために検討を重ねた結果、下肢脈波から得られる情報にも下肢動脈の狭窄に関連して変動する情報（これを狭窄関連脈波情報とする）があることを見いたした。そして、その狭窄関連脈波情報に基づいて下肢動脈の狭窄についての予備的な診断を行い、下肢動脈に狭窄があると疑われる場合にのみ下肢上肢血圧指數を算出すれば、下肢動脈の狭窄を診断する際の患者の苦痛を少なくすることができるとの考えに至った。本発明は、係る思想に基づいてなされたものである。

【0007】すなわち、前記目的を達成するための請求項1に係る発明は、生体の下肢に巻回されるカフを用いてその下肢における血圧値である下肢血圧値を測定する下肢血圧測定装置と、その生体の上肢に巻回されるカフを用いてその上肢における血圧値である上肢血圧値を測定する上肢血圧測定装置と、その下肢血圧測定装置により測定された下肢血圧値とその上肢血圧測定装置により測定された上肢血圧値とに基づいて、下肢上肢血圧指數を算出する下肢上肢血圧指數算出手段とを備えた下肢上肢血圧指數測定装置であって、前記生体の下肢に装着されて下肢脈波を検出する下肢脈波検出装置と、その下肢脈波検出装置により検出された下肢脈波に基づいて、下肢の狭窄に関連して変動する狭窄関連脈波情報を決定する狭窄関連脈波情報決定手段とを含むことを特徴とする。

【0008】本発明によれば、下肢血圧測定装置による下肢血圧値の測定に先立って、狭窄関連脈波情報を決定手段により、下肢脈波検出装置によって検出される下肢脈波から狭窄関連脈波情報を決定すれば、その狭窄関連脈波情報をから下肢動脈の狭窄の疑いがないと判断できる場合には、下肢上肢血圧指數を算出するために下肢血圧測

定装置による血圧測定を実行する必要がなくなる。従って、下肢動脈の狭窄を診断する際の患者の苦痛が少なくなる。なお、上記判断は、自動的に判断されるものであっても、人が判断するものであってもよい。

【0009】また、前記目的を達成するための請求項2に係る発明は、前記狭窄関連脈波情報決定手段により決定された狭窄関連脈波情報が、予め設定された異常範囲内の値であることにに基づいて下肢動脈に狭窄の疑いがあると判定する予備判定手段と、その予備判定手段により狭窄の疑いがあると判定された場合には、前記下肢血圧測定装置および前記上肢血圧測定装置により血圧測定を実行させる血圧測定起動手段とをさらに含むことを特徴とする。

【0010】この発明によれば、予備判定手段によって狭窄の疑いがあると判定された場合には、血圧測定起動手段により自動的に下肢血圧測定装置および上肢血圧測定装置による血圧測定が実行されて、下肢上肢血圧指數が算出される利点がある。

【0011】また、前記目的を達成するための請求項3に係る発明は、前記狭窄関連脈波情報決定手段として、次の3つの手段のうち、少なくとも1つを含むことを特徴とする。

(1)前記下肢脈波検出装置により検出される下肢脈波に基づいて、前記下肢を脈波が伝播する速度に関連する下肢脈波伝播速度情報を算出する下肢脈波伝播速度情報算出手段

(2)前記下肢脈波検出装置により検出される下肢脈波の先鋭度を算出する先鋭度算出手段

(3)前記下肢脈波検出装置により検出される下肢脈波の上昇部分の特徴値である上昇特徴値を決定する上昇特徴値決定手段

【0012】また、前記目的を達成するための請求項4に係る発明は、前記狭窄関連脈波情報算出手段として、前記下肢脈波検出装置により検出される下肢脈波に基づいて、前記下肢を脈波が伝播する速度に関連する下肢脈波伝播速度情報を算出する下肢脈波伝播速度情報算出手段を含む請求項1または2に記載の下肢上肢血圧指數測定装置であって、前記生体の上肢に装着されて上肢脈波を検出する上肢脈波検出装置と、その上肢脈波検出装置により検出された上肢脈波に基づいて、前記上肢を脈波が伝播する速度に関連する上肢脈波伝播速度情報を算出する上肢脈波伝播速度情報算出手段と、その上肢脈波伝播速度情報算出手段により算出される上肢脈波伝播速度情報に基づいて、予め記憶された関係から下肢脈波伝播速度情報の正常範囲を決定する正常範囲決定手段と、前記下肢脈波伝播速度情報算出手段により算出された下肢脈波伝播速度情報が、前記正常範囲決定手段により決定された正常範囲外であることにに基づいて、下肢動脈に狭窄の疑いがあると判定する予備判定手段とをさらに含むことを特徴とする。

【0013】この発明によれば、正常範囲決定手段により、上肢脈波伝播速度情報に基づいて予め記憶された関係から下肢脈波伝播速度情報の正常範囲が決定される。そして、予備判定手段により、下肢脈波伝播速度情報算出手段により算出された下肢脈波伝播速度情報が正常範囲外であることにに基づいて下肢動脈に狭窄の疑いがあると判定される。上記正常範囲は、測定毎に実際に測定された上肢脈波伝播速度情報に基づいて決定されるので、実際に測定された下肢脈波伝播速度情報が多数の患者に当てはまるよう設定された一般的な正常範囲にあるか否かに基づいて下肢動脈の狭窄の疑いが判断される場合に比較して、下肢動脈における狭窄の有無の予備的判断がより精度よく行える。

【0014】また、前記目的を達成するための請求項5に係る発明は、請求項1または2に記載の下肢上肢血圧指數測定装置であって、前記下肢脈波検出装置は、前記生体の左右の下肢にそれぞれ装着されており、前記狭窄関連脈波情報決定手段は、左下肢脈波および右下肢脈波に基づいて前記狭窄関連脈波情報をそれぞれ決定するものであることを特徴とする。

【0015】この発明によれば、左下肢脈波に基づく狭窄関連脈波情報と右下肢脈波に基づく狭窄関連脈波情報とを比較して両者の相違が大きい場合には、左右いずれかの下肢に狭窄があり、その狭窄のために両者の相違が大きくなっている可能性があると判断できるので、下肢動脈における狭窄の有無の予備的診断がより精度よく行える。

【0016】また、前記目的を達成するための請求項6に係る発明は、請求項5に記載の下肢上肢血圧指數測定装置であって、前記狭窄関連脈波情報決定手段においてそれぞれ決定された左下肢脈波に基づく狭窄関連脈波情報と右下肢脈波に基づく狭窄関連脈波情報との相違値が予め設定された基準値以上である場合には、下肢動脈に狭窄の疑いがあると判定する予備判定手段を含むことを特徴とする。

【0017】この発明によれば、左下肢脈波に基づく狭窄関連脈波情報と右下肢脈波に基づく狭窄関連脈波情報との相違値が基準値以上である場合には、予備判定手段により、狭窄の疑いがあると判定されるので、下肢動脈における狭窄の有無の予備的判断がより精度よく行える。

【0018】

【発明の好適な実施の形態】以下、本発明の一実施形態を図面に基づいて詳細に説明する。図1は、本発明が適用された足首上腕血圧指數測定装置10の構成を説明するブロック図である。すなわち、図1の足首上腕血圧指數測定装置10は、下肢として足首12（右足首12Rおよび左足首12L）が選択され、上肢として上腕14（右上腕14Rおよび左上腕14L）が選択された下肢上腕血圧指數測定装置である。なお、この足首上腕血圧

指數測定装置10による測定は、上腕14と足首12とが略同じ高さとなるように、患者16が伏臥位・側臥位・側臥位のいずれかの状態で測定される。

【0019】足首12R, 12Lには足首用カフ18R, 18Lがそれぞれ巻回され、上腕14R, 14Lには上腕用カフ20R, 20Lがそれぞれ巻回されている。これらのカフ18, 20は、巻回している部位を圧迫する圧迫帶であり、布或いはポリエスチル等の伸展性のない素材から成る帶状外袋内にゴム製袋を有している。

【0020】上腕用カフ20R, 20Lは配管22a, 22bを介して血圧測定装置本体24a, bにそれぞれ接続され、足首用カフ18R, 18Lは配管22c, dを介して血圧測定装置本体24c, dにそれぞれ接続されている。

【0021】それら4つの血圧測定装置本体24a, b, c, dは同一の構成を有するので、上腕用カフ20Lと接続されている血圧測定装置本体24bを例として血圧測定装置本体24の構成を説明する。血圧測定装置本体24bは、調圧弁26b, 圧力センサ28b, 静圧弁別回路30b, 脈波弁別回路32bを備えており、前記配管22bは圧力センサ28bおよび調圧弁26bに接続されている。また、調圧弁26bは、配管34を介して空気ポンプ36に接続されている。

【0022】上記調圧弁26bは、空気ポンプ36により発生させられた圧力空気を上腕用カフ20L内へ供給することを許容する圧力供給状態、上腕用カフ20L内の圧力を維持する圧力維持状態、電動バルブの開度が制御されることにより上腕用カフ20L内の圧力を所定の速度で徐々に排圧する徐速排圧状態、および上腕用カフ20L内を急速に排圧する急速排圧状態の4つの状態に切り替えられるようになっている。

【0023】圧力センサ28bは、上腕用カフ20L内の圧力を検出してその圧力を表す圧力信号SP_bを静圧弁別回路30bおよび脈波弁別回路32bにそれぞれ供給する。静圧弁別回路30bはローパスフィルタを備え、圧力信号SP_bに含まれる定的な圧力すなわちカフ圧PC_bを表すカフ圧信号SK_bを弁別してそのカフ圧信号SK_bを図示しないA/D変換器を介して演算制御装置38へ供給する。

【0024】脈波弁別回路32bはバンドパスフィルタを備え、圧力信号SP_bの振動成分である脈波信号SM_bを周波数的に弁別してその脈波信号SM_bを図示しないA/D変換器を介して演算制御装置38へ供給する。この脈波信号SM_bは、上腕用カフ20Lにより圧迫される左上腕14Lの動脈からの上腕脈波WA_Lを表すので、脈波弁別回路32bは上肢脈波検出装置として機能している。また、同様に、血圧測定装置本体24aの脈波弁別回路32aは、右上腕14Rの動脈からの上腕脈波WA_Rを表す脈波信号SM_aを弁別する上肢脈波検出装置として機能

し、血圧測定装置本体24cの脈波弁別回路32cは、右足首12Rの動脈からの足首脈波WL_Rを表す脈波信号S_{Mc}を弁別する下肢脈波検出装置として機能し、血圧測定装置本体24dの脈波弁別回路32dは、左足首12Lの動脈からの足首脈波WL_Lを表す脈波信号S_{Md}を弁別する下肢脈波検出装置として機能する。

【0025】なお、上腕用カフ20L、血圧測定装置本体24b、および空気ポンプ36により上腕血圧測定装置40Lが構成される。同様に、上腕用カフ20R、血圧測定装置本体24a、および空気ポンプ36により上腕血圧測定装置40Rが構成され、足首用カフ18R、血圧測定装置本体24c、および空気ポンプ36により足首血圧測定装置42Rが構成され、足首用カフ18L、血圧測定装置本体24d、および空気ポンプ36により足首血圧測定装置42Lが構成される。

【0026】心音マイク44は、生体の胸部表皮上の所定部位に装着されて、心音を表す心音信号SHを検出して出力する。心音マイク44から出力された心音信号SHは、A/D変換器46を介して演算制御装置38へ供給される。上記心音信号SHが表す心音は、生体の心拍に同期して発生する心拍同期信号であることから、心音信号SHを出力する心音マイク44は心拍同期信号検出装置として機能している。

【0027】上記演算制御装置38は、CPU48、ROM50、RAM52、および図示しないI/Oポート等を備えた所謂マイクロコンピュータにて構成されており、CPU48は、ROM50に予め記憶されたプログラムに従ってRAM52の記憶機能を利用しつつ信号処理を実行することにより、I/Oポートから駆動信号を出力して空気ポンプ36および血圧測定装置本体24内の調圧弁26を制御するとともに、足首上腕血圧指数(Angle/Arm Blood Pressure=ABI)の算出などを行い、その算出したABIなどを表示器54に表示する。

【0028】図2は、上記演算制御装置38の制御機能のうち、ABIの測定が必要なほどに狭窄の疑いがあるか否かを判定するための予備的な診断に関する機能の要部を説明する機能ブロック線図である。

【0029】カフ圧制御手段60は、血圧測定においては、空気ポンプ36およびそれに接続された4つの調圧弁26a, b, c, dを制御して、上腕用カフ20および足首用カフ18のカフ圧PC_a, PC_b, PC_c, PC_dを、所定の目標圧力値P_{CM}（たとえば、上腕用カフ20については180mmHg程度、足首用カフ18については240mmHg程度の圧力値）まで急速昇圧させ、その後、5mmHg/sec程度の速度で徐速降圧させる。また、狭窄関連脈波情報を算出するための脈波の検出においては、空気ポンプ36およびそれに接続された4つの調圧弁26a, b, c, dを制御して、カフ圧PC_a, PC_b, PC_c, PC_dを所定の脈波検出圧まで昇圧させた後、一定時間その圧力を保持させる。上記脈波検出圧は、一般的な最低血圧値よりも低く、且つ

カフ18, 20にそのカフ下の動脈において発生した圧力振動波が伝達されてカフ18, 20にその圧力振動波を表す脈波が十分な信号強度で発生するような圧力であり、たとえば60mmHgである。

【0030】上昇特徴値決定手段62は、カフ圧制御手段60により足首用カフ18が前記脈波検出圧に維持されている状態で脈波弁別回路32cにより抽出される右足首脈波WL_Rおよび脈波弁別回路32dにより抽出される左足首脈波WL_Lの上昇部分（すなわち立ち上がり点からピークまで）の特徴を表す上昇特徴値をそれぞれ決定する。図3は、足首脈波WLを例示する図であり、上昇特徴値には、たとえば図3に示すものが含まれる。すなわち、立ち上がり点aからピークbまでの足首脈波WLが上昇する期間として算出されるU-time msec）、立ち上がり点aからピークbまでで増加率が最大となる点すなわち最大傾斜点cにおける接線Lの傾きγ、立ち上がり点aから最大傾斜点cまでの前半時間、最大傾斜点cからピークbまでの後半時間、その前半時間と後半時間との比、などが上昇特徴値に含まれる。足首12R, 12Lの上流側の下肢における狭窄の程度が大きいほど、足首脈波WL_R, WL_Lは立ち上がり部分の傾斜がなだらかになる傾向にがあるので、足首12R, 12Lの上流側の下肢に狭窄があると、上昇特徴値はその狭窄に関連して変化する。たとえば、U-timeは、上流側における狭窄の程度が大きいほど長くなる。従って、足首脈波WL_R, WL_Lから算出される上昇特徴値は狭窄関連脈波情報であり、上昇特徴値決定手段62は狭窄関連脈波情報決定手段として機能する。

【0031】先鋭度算出手段64は、カフ圧制御手段60により足首用カフ18が前記脈波検出圧に維持されている状態で脈波弁別回路32cにより抽出される右足首脈波WL_Rおよび脈波弁別回路32dにより抽出される左足首脈波WL_Lの先鋭度をそれぞれ算出する。上記先鋭度とは、脈波の上方への尖り具合を示す値であり、たとえば、図3に示す一拍分の区間の足首脈波WLを積分（加算）することにより算出される脈波面積Sを、ピーク高さHと脈拍周期Wとの積（W×H）で割ることにより、すなわちS/（W×H）なる演算が行われることにより算出される正規化脈波面積VR、最高ピークbまでの前半部の面積S1あるいは最高ピークb以降の後半部の面積S2を正規化したもの、H×(2/3)に相当する高さの幅寸法Iを正規化したI/W等が先鋭度である。また、上記正規化脈波面積VRは、%MAPとも称され、ピーク高さHすなわち脈圧に対する脈波面積Sの重心位置の高さGの割合（=100×H/G）としても算出できる。足首12R, Lの上流側の下肢に狭窄があると、足首脈波WL_R, WL_Lの振幅は弱くなり、脈波の上方への尖り具合は鈍くなる。すなわち、足首12R, 12Lの上流側の下肢に狭窄があると、上記先鋭度は小さくなるので、足首脈波WL_R, WL_Lから算出される先鋭度は狭窄関連脈波情報

であり、先鋭度算出手段 6.4 は狭窄関連脈波情報決定手段として機能する。

【0032】上肢脈波伝播速度情報算出手段 6.6 は、上肢を含む所定の2部位間（ただし下肢は含まない）を脈波が伝播する速度に関連する上肢脈波伝播速度情報を算出するものである。上記2部位は、たとえば、上腕用カフ2.0が装着されている部位および心臓である。また、上肢脈波伝播速度情報には、上肢を脈波が伝播する時間である上肢脈波伝播時間や上肢を脈波が伝播する速度である上肢脈波伝播速度が含まれる。上記2部位を上腕用カフ2.0が装着されている部位と心臓とする場合には、たとえば、心音マイク4.4により検出される心音の周期的に繰り返す所定の部位（I音の開始点など）が発生した時点と、上肢脈波検出装置として機能する脈波弁別回路3.2により抽出される上腕脈波WAの周期的に繰り返す所定部位（立ち上がり点など）が発生した時点との時間差を上肢脈波伝播時間hbDT(sec)として算出し、或いは、その上肢脈波伝播時間hbDTに基づいて予めROM5.0に記憶された式1から上肢脈波伝播速度hbPWV(cm/sec)を算出する。尚、式1において、L1(cm)は大動脈弁から大動脈を経て上腕用カフ2.0が装着される部位までの距離であり、予め実験に基づいて決定された一定値が用いられる。

$$(式1) \quad hbPWV = L1/hbDT$$

【0033】下肢脈波伝播速度情報算出手段 6.8 は、下肢を含む所定の2部位間を脈波が伝播する速度に関連する下肢脈波伝播速度情報を算出する。上記2部位は、たとえば、心臓および足首用カフ1.8Rまたは1.8Lが装着されている部位である。また、下肢脈波伝播速度情報には、上肢脈波伝播速度情報と同様に、下肢脈波伝播時間や下肢脈波伝播速度が含まれる。上記2部位間において下肢に狭窄があると、下肢脈波伝播時間は長くなり下肢脈波伝播速度は遅くなるので、下肢脈波伝播速度情報は狭窄関連脈波情報であり、下肢脈波伝播速度情報算出手段 6.8 は狭窄関連脈波情報決定手段として機能する。上記2部位を心臓および足首用カフ1.8が装着されている部位とする場合には、たとえば、心音マイク4.4により検出される心音の周期的に繰り返す所定の部位（I音の開始点など）が発生した時点と、下肢脈波検出装置として機能する脈波弁別回路3.2cおよび3.2dにより抽出される足首脈波WL_R、WL_Lの周期的に繰り返す所定部位（立ち上がり点など）が発生した時点との時間差を下肢脈波伝播時間baDT(sec)として算出し、或いは、その下肢脈波伝播時間baDTに基づいて予めROM5.0に記憶された式2から下肢脈波伝播速度baPWV(cm/sec)を算出する。尚、式2において、L2(cm)は大動脈弁から足首用カフ1.8が装着される部位までの距離であり、予め実験に基づいて決定された一定値が用いられる。

$$(式2) \quad baPWV = L2/baDT$$

【0034】正常範囲決定手段 7.0 は、上肢脈波伝播速

度情報算出手段 6.6 により算出された上肢脈波伝播速度情報に基づいて、上肢脈波伝播速度情報と下肢脈波伝播速度情報との間の予め記憶された関係から下肢脈波伝播速度情報の正常範囲を決定する。上肢および下肢ともに狭窄がない場合には、上肢脈波伝播速度情報と下肢脈波伝播速度情報との間には一定の比例関係が成立するので、上肢に狭窄がないと仮定して、上肢脈波伝播速度情報算出手段 6.8 により実際に算出された上肢脈波伝播速度情報を用いて上記予め記憶された比例関係から、上記正常範囲を決定するのである。図4は、心臓と上腕との間で算出された上肢脈波伝播速度hbPWVと、心臓と足首との間で算出された下肢脈波伝播速度baPWVとの間の関係を示す図である。予め記憶された関係として図4に示す関係を用いる場合、たとえば、上肢脈波伝播速度hbPWVから決定される下肢脈波伝播速度baPWVを中心としてその下肢脈波伝播速度baPWVの-10%～+10%の範囲を正常範囲に決定する。なお、図4において、下肢脈波伝播速度baPWVの方が上肢脈波伝播速度hbPWVよりも速いのは、脈波伝播速度PWVは血管径の1/2乗に反比例して速くなること、および足首の方が上腕よりも血管径が細いことによる。

【0035】上腕血圧値決定手段 7.2 は、カフ圧制御手段 6.0 により上腕用カフ2.0が徐速降圧させられる過程において、順次採取される脈波信号SM_RまたはSM_Lが表す上腕脈波WA_R、WA_Lの振幅の変化に基づきよく知られたオシロメトリック法を用いて、右上腕1.4Rの血圧値BPである右上腕最高血圧値BP_{ASYS}(R)・右上腕最低血圧値BP_{ADIA}(R)・右上腕平均血圧値BP_{AMEAN}(R)、および左上腕1.4Lにおける血圧値BPである左上腕最高血圧値BP_{ASYS}(L)・左上腕最低血圧値BP_{ADIA}(L)・左上腕平均血圧値BP_{AMEAN}(L)を決定し、その決定した右上腕最高血圧値BP_{ASYS}(R)、左上腕最高血圧値BP_{ASYS}(L)等を表示器5.4に表示する。

【0036】相違値算出手段 7.4 は、下肢脈波伝播速度情報算出手段 6.8 により算出された左下肢の脈波伝播速度情報と右下肢の脈波伝播速度情報との相違値、上昇特徴値決定手段 6.2 により決定された左下肢の上昇特徴値と右下肢の上昇特徴値との相違値、および先鋭度算出手段 6.4 により算出された左下肢の先鋭度と右下肢の先鋭度との相違値を算出する。上記相違値とは、脈波伝播速度情報などの狭窄関連脈波情報が左右でどの程度異なっているかを示す値であり、たとえば、左右の差または比などである。

【0037】予備判定手段 7.6 は、狭窄関連脈波情報決定手段である下肢脈波伝播速度情報算出手段 6.8、上昇特徴値決定手段 6.2、先鋭度算出手段 6.4 によりそれぞれ算出された下肢脈波伝播速度情報、上昇特徴値、先鋭度が、それについて狭窄の疑いがある範囲として設定された異常範囲内の値であることにに基づいて、下肢動脈に狭窄の疑いがあると判定する。

【0038】上記下肢脈波伝播速度情報の異常範囲とは、前記正常範囲決定手段70で決定された正常範囲外の範囲である。また、上昇特徴値の異常範囲および先鋭度の異常範囲は予め実験に基づいて決定されている。上昇特徴値としてU-timeが算出される場合には、異常範囲はたとえば180msec以上に設定され、先鋭度として%MAPが算出される場合には異常範囲はたとえば42%以下に設定される。また、上記下肢脈波伝播速度情報、上昇特徴値、先鋭度の3つのうち少なくとも一つが異常範囲である場合に下肢動脈に狭窄の疑いがあると判定してもよいし、いざれか2つが異常範囲である場合や、3つすべてが異常範囲である場合に下肢動脈に狭窄の疑いがあると判定してもよい。なお、下肢脈波伝播速度情報、上昇特徴値、先鋭度は左右の下肢についてそれぞれ決定されるので、下肢動脈の狭窄の疑いは左右の下肢それぞれについて判定できる。

【0039】予備判定手段76は、さらに、前記相違値算出手段72で算出された下肢脈波伝播速度情報、上昇特徴値、先鋭度の相違値が予め設定された基準値以上であることに基づいて、下肢動脈に狭窄の疑いがあると判定する。相違値が基準値以上となるのは、左右の下肢のいざれか一方に狭窄があるためと考えられるからである。なお、相違値に基づいて下肢動脈に狭窄の疑いがあると判定する場合には、左右いざれの下肢に狭窄の疑いがあるかまでは判定できない。

【0040】予備判定手段76は、上記下肢脈波伝播速度情報、上昇特徴値および先鋭度がいざれも異常範囲でなく且つ前記相違値が基準値よりも小さい場合には、さらに、上腕血圧値決定手段72により決定された上腕最高血圧値BP_{ASYS}が予め設定された最低値（たとえば100mmHg）より小さいかを判断する。このように、上腕最高血圧値BP_{ASYS}が予め設定された最低値より小さいかを判断するのは、上腕最高血圧値BP_{ASYS}が予め設定された最低値より小さい場合には、上肢に狭窄があることによって上腕最高血圧値BP_{ASYS}が低下している可能性があり、上肢にも狭窄がある場合にはABIを算出しても下肢動脈の狭窄を診断することが困難だからである。

【0041】血圧測定起動手段として機能するABI測定起動手段78は、予備判定手段76により下肢動脈に狭窄の疑いがあると判定された場合であって上腕最高血圧値BP_{ASYS}が前記最低値以上である場合に、上腕血圧値決定手段72および後述する足首血圧値決定手段82を実行させる。なお、一方の下肢のみに狭窄の疑いがある場合には足首血圧値決定手段82により狭窄の疑いのある側の足首12についてのみ血圧測定を実行させる。また、上腕血圧値決定手段72による上腕14についてのみ血圧測定を実行させてもよいが、好ましくは、両側の上腕14について血圧測定を実行させる。

【0042】下肢血圧測定起動手段80は、予備判定手

段76により下肢動脈に狭窄の疑いがあると判定された場合であって上腕血圧値BP_{ASYS}が前記最低値より小さい場合に、足首血圧値決定手段82を実行させる。上腕血圧値BP_{ASYS}が前記最低値より小さい場合には、ABIから下肢動脈の狭窄を診断することが困難であるので、足首血圧値BP_Lの絶対値のみによって下肢動脈の狭窄を診断するためである。

【0043】図5は、演算制御装置38の制御機能のうち、図2に示す機能が実行されることによって下肢動脈に狭窄の疑いがあると判定された場合に実行される機能の要部を説明する機能ブロック線図である。

【0044】足首血圧値決定手段82は、ABT測定起動手段78または下肢血圧測定起動手段80により実行され、カフ圧制御手段60により狭窄の疑いのある一方または両方の下肢の足首12に巻回された足首用カフ18の圧迫圧力を制御させ、足首用カフ18の圧迫圧力が徐速降圧させられる過程において、順次採取される脈波信号SM_CまたはSM_dが表す下肢脈波WL_R、WL_Lの振幅の変化に基づきよく知られたオシロメトリック法を用いて、右足首12Rにおける血圧値BPである右足首最高血圧値BP_{LSYS}(R)・右足首最低血圧値BP_{LDIA}(R)・右足首平均血圧値BP_{LMEAN}(R)、および左足首12Lにおける血圧値BPである左足首最高血圧値BP_{LSYS}(L)・左足首最低血圧値BP_{LDIA}(L)・左足首平均血圧値BP_{LMEAN}(L)を決定し、その決定した右足首最高血圧値BP_{LSYS}(R)、左足首最高血圧値BP_{LSYS}(L)等を表示器54に表示する。

【0045】下肢上肢血圧指数算出手段として機能する足首上腕血圧指数算出手段84は、足首血圧値決定手段82により決定された右足首血圧値BP_L(R)（たとえば右足首最高血圧値BP_{LSYS}(R)）または左足首血圧値BP_L(L)（たとえば左足首最高血圧値BP_{LSYS}(L)）を、上腕血圧値決定手段72により決定された上腕血圧値BP_Aのうち上記足首血圧値BP_Lに対応する上腕血圧値BP_A（たとえば足首最高血圧値BP_{LSYS}には上腕最高血圧値BP_{ASYS}が対応する）で割ることにより右足首上腕血圧指数（=ABIR）または左足首上腕血圧指数（=ABIL）を算出する。そして、その算出したABIR, ABILの値を表示器54に表示する。

【0046】下肢動脈の狭窄がある場合には、右足首血圧値BP_L(R)や左足首血圧値BP_L(L)が低下するので、下肢動脈の狭窄が場合には、これらABIR, ABILは低下する。従って、ABIR, ABILが基準値（たとえば0.9）よりも小さい場合には下肢動脈に狭窄がある疑いが強いと判断できる。なお、ABIの算出において上腕血圧値BP_Aとして右上腕血圧値BP_L(L)および左上腕血圧値BP_A(L)のいざれを用いるかは、血圧測定に先立って予め決定されていてもよいが、好ましくは、高い方の値を用いる。高い方の値を用いるとABIが小さくなるので、ABIに基づいて下肢動脈の狭窄を発見しやすくなるからである。

【0047】図6乃至図9は、図2および図5に示した

演算制御装置 3 8 の制御機能の要部をさらに具体的に説明するためのフローチャートであって、図 6 は予備判定のための信号を読み込む信号読み込みルーチンであり、図 7 はその読み込んだ信号に基づいて予備判定を行う予備判定ルーチンであり、図 8 は ABI 測定ルーチンであり、図 9 は足首血圧測定ルーチンである。

【0048】まず、図 6 の信号読み込みルーチンを説明する。図 6 のステップ（以下、ステップを省略する）S A 1 では、血圧測定装置本体 2 4 a, b, c, d にそれぞれ備えられている調圧弁 2 6 a, b, c, d が圧力供給状態とされ且つ空気ポンプ 3 6 が駆動されることにより、足首用カフ 1 8 R, 1 8 L および上腕用カフ 2 0 R, 2 0 L の昇圧が開始され、続く S A 2 では、4 つのカフ 1 8 R, 1 8 L, 2 0 R, 2 0 L のカフ圧 PC が、脈波検出圧として設定された 60mmHg 以上となったか否かが判断される。この S A 2 の判断が否定された場合は、S A 2 の判断が繰り返される。

【0049】そして、カフ圧 PC の上昇により上記 S A 2 の判断が肯定されると、続く S A 3 では、空気ポンプ 3 6 が停止され且つ調圧弁 2 6 が圧力維持状態に切り替えられることによりカフ圧 PC が維持される。上記 S A 1 乃至 S A 3 はカフ圧制御手段 6 0 に相当する。

【0050】続く S A 4 では、血圧測定装置本体 2 4 b, c, d にそれぞれ備えられている脈波弁別回路 3 2 b, c, d から供給される脈波信号 SM_b, SM_c, SM_d および心音マイク 4 4 から供給される心音信号 SH が一拍分読み込まれる。

【0051】続いて、カフ圧制御手段 6 0 に相当する S A 5 乃至 S A 8 が実行される。S A 5 では、調圧弁 2 6 c, d が急速排圧状態に切り替えられることにより、足首用カフ 1 8 R, L のカフ圧 PC_c, PC_d が解放され、続く S A 6 では、調圧弁 2 6 a, 2 6 b が再び圧力供給状態に切り替えられ且つ空気ポンプ 3 6 が再度駆動されることにより、上腕用カフ 2 0 R, 2 0 L の急速昇圧が開始される。続く S A 7 では、上腕用カフ 2 0 R, 2 0 L のカフ圧 PC_a, PC_b がそれぞれ 180mmHg に設定された目標圧迫圧 P_{CM} 以上となったか否かが判断される。この S A 7 の判断が否定された場合は、上記 S A 6 以下が繰り返し実行されることによりカフ圧 PC_a, PC_b の上昇が継続される。

【0052】そして、カフ圧 PC_a, PC_b の上昇により上記 S A 7 の判断が肯定されると、続く S A 8 では、空気ポンプ 3 6 が停止され且つ調圧弁 2 6 a, 2 6 b が徐速排圧状態に切り替えられて、上腕用カフ 2 0 R, 2 0 L 内の圧力が予め定められた 5mmHg/sec 程度の緩やかな速度で下降させられる。

【0053】次に、上腕血圧値決定手段 7 2 に相当する S A 9 の血圧値決定ルーチンが実行される。すなわち、脈波弁別回路 3 2 a, 3 2 b から逐次供給される脈波信号 SM_a, SM_b が表す上腕脈波 WA_R, WA_L の振幅が一拍毎に決定

され、その振幅の変化に基づいて、よく知られたオシロメトリック方式の血圧値決定アルゴリズムに従って右上腕最高血圧値 BP_{ASYS}(R) および左上腕首最高血圧値 BP_{ASYS}(L) 等が決定される。

【0054】続いて、カフ圧制御手段 6 0 に相当する S A 1 0 において、2 つの調圧弁 2 6 a, 2 6 b が急速排圧状態に切り替えられることにより、上腕用カフ 2 0 R, 2 0 L 内が急速に排圧させられて、信号読み込みルーチンは終了させられる。

【0055】信号読み込みルーチンが終了させられるとして、続いて図 7 の予備判定ルーチンが実行される。図 7 では、まず上肢脈波伝播速度情報算出手段 6 6 に相当する S B 1 が実行される。S B 1 では、図 6 の S A 4 で読み込まれた心音信号 SH に基づいて心音の I 音の開始点が決定されるとともに、その S A 4 で読み込まれた脈波信号 SM_b に基づいてその脈波信号 SM_b が表す左上腕脈波 WA_L の立ち上がり点が決定され、I 音の開始点と左上腕脈波 WA_L の立ち上がり点との時間差すなわち上肢脈波伝播時間 hbDT が算出され、さらに、その上肢脈波伝播時間 hbDT が前記式 1 に代入されて上肢脈波伝播速度 hbPWV が算出される。

【0056】続いて正常範囲決定手段 7 0 に相当する S B 2 が実行される。S B 2 では、上記 S B 1 で算出された上肢脈波伝播速度 hbPWV に基づいて、前述の図 4 の関係から下肢脈波伝播速度 baPWV が決定され、その決定された下肢脈波伝播速度 baPWV の -10% から +10% の範囲が下肢脈波伝播速度 hbPWV の正常範囲に決定される。

【0057】続いて下肢脈波伝播速度情報算出手段 6 8 に相当する S B 3 が実行されて、右下肢脈波伝播速度 baPWV(R) および左下肢脈波伝播速度 baPWV(L) が算出される。すなわち、図 6 の S A 4 で読み込まれた脈波信号 SM_c, SM_d に基づいてその脈波信号 SM_c, SM_d がそれぞれ表す右足首脈波 WL_R および左足首脈波 WL_L の立ち上がり点がそれぞれ決定され、続いて、前記 S B 1 で決定された左上腕脈波 WA_L の立ち上がり点と上記右足首脈波 WL_R の立ち上がり点との時間差すなわち右下肢脈波伝播時間 baDT(R)、および前記 S B 1 で決定された左上腕脈波 WA_L の立ち上がり点と上記左足首脈波 WL_L の立ち上がり点との時間差すなわち左下肢脈波伝播時間 baDT(L) が算出され、さらに、それら右下肢脈波伝播時間 baDT(R) および左下肢脈波伝播時間 baDT(L) が前記式 2 に代入されて右下肢脈波伝播速度 baPWV(R) および左下肢脈波伝播速度 baPWV(L) が算出される。また、算出された右下肢脈波伝播速度 baPWV(R) および左下肢脈波伝播速度 baPWV(L) は表示器 5 4 に表示される。

【0058】続いて上昇特徴値決定手段 6 2 に相当する S B 4 が実行される。S B 4 では、図 6 の S A 4 で読み込まれた脈波信号 SM_c, SM_d に基づいてその脈波信号 SM_c, SM_d がそれぞれ表す右足首脈波 WL_R および左足首脈波 WL_L の

立ち上がり点およびピークが決定され、右足首脈波 WL_R のピークと立ち上がり点との時間差が $U\text{-time}(R)$ として算出され、左足首脈波 WL_L のピークと立ち上がり点との時間差が $U\text{-time}(L)$ として算出される。また、算出された $U\text{-time}(R)$ 、 $U\text{-time}(L)$ は表示器54に表示される。

【0059】続いて先鋭度算出手段64に相当するSB5が実行される。SB5では、図6のSA4で読み込まれた脈波信号 SM_c が表す右足首脈波 WL_R について、その面積Sがピーク高さHと脈拍周期Wとの積($W \times H$)で割られることにより%MAP(R)が算出されるとともに、図6のSA4で読み込まれた脈波信号 SM_d が表す左足首脈波 WL_L について、その面積Sがピーク高さHと脈拍周期Wとの積($W \times H$)で割られることにより%MAP(L)が算出される。また、算出された%MAP(R)、%MAP(L)は表示器54に表示される。

【0060】続くSB6では、前記SB3で算出された右下肢脈波伝播速度baPWV(R)、左下肢脈波伝播速度baPWV(L)、前記SB4で算出された $U\text{-time}(R)$ 、 $U\text{-time}(L)$ 、上記SB5で算出された%MAP(R)、%MAP(L)がそれぞれについて予め設定された異常範囲内にあるか否かが判断される。すなわち右下肢脈波伝播速度baPWV(R)、左下肢脈波伝播速度baPWV(L)については、前記SB2で決定された正常範囲外であるか否かが判断され、 $U\text{-time}(R)$ 、 $U\text{-time}(L)$ については180msec以上であるか否かが判断され、%MAP(R)、%MAP(L)については42%以下であるか否かが判断される。そして、それらのうちの少なくとも一つが異常範囲内にある場合にはSB6の判断が肯定される。このSB6の判断が肯定された場合には、下肢動脈に狭窄があることが疑われる所以、図8のABI測定ルーチンが実行される。一方、SB6の判断が否定された場合には、相違値算出手段74に相当するSB7が実行される。

【0061】SB7では、前記SB3で算出された右下肢脈波伝播速度baPWV(R)と左下肢脈波伝播速度baPWV(L)との脈波伝播速度差(絶対値) ΔPWV 、前記SB4で算出された $U\text{-time}(R)$ と $U\text{-time}(L)$ との差 $\Delta U\text{-time}$ (絶対値)、および前記SB5で算出された%MAP(R)と%MAP(L)との差 $\Delta \%MAP$ (絶対値)が相違値として算出される。

【0062】続くSB8では、上記SB7で算出された ΔPWV 、 $\Delta U\text{-time}$ 、 $\Delta \%MAP$ が、それぞれについて予め設定された基準値以上であるか否かが判断される。そして、それら ΔPWV 、 $\Delta U\text{-time}$ 、 $\Delta \%MAP$ のうちの少なくとも一つが基準値以上である場合にはSB8の判断が肯定される。このSB8の判断が肯定された場合には、いずれか一方の下肢の下肢動脈に狭窄の疑いがあるので、図8のABI測定ルーチンが実行されて、両下肢のABIが測定される。このように、SB6またはSB8の判断が肯定された場合にはABI測定ルーチンが実行されるので、SB6およびSB8がABI測定起動手段78に相当する。

【0063】一方、SB8の判断が否定された場合には、続いてSB9が実行される。SB9では、図6のS

A9で決定された上腕最高血圧値 BP_{ASYS} が最低値として予め設定された100mmHgより小さいか否かが判断される。この判断が肯定された場合には、図9の足首血圧測定ルーチンが実行される。従って、SB9は下肢血圧測定起動手段80に相当する。一方、SB9の判断が否定された場合には、下肢動脈に狭窄の疑いないと判断されてABI測定ルーチンも足首血圧測定ルーチンも実行されることなく本ルーチンは終了させられる。このように、SB6、SB8、SB9により下肢動脈に狭窄の疑いがあるか否かが判断されるので、SB6、SB8、SB9は予備判定手段76にも相当する。

【0064】続いて、図8のABI測定ルーチンを説明する。図8のABI測定ルーチンでは、まず、カフ圧制御手段60に相当するSC1乃至SC3が実行される。SC1では、2つの上腕用カフ20R、20Lにそれぞれ接続された調圧弁26a、26b、および図7のSB6またはSB8で狭窄の疑いがあると判定された側の足首用カフ18(SB8において狭窄の疑いがあると判定された場合には両側の足首用カフ18)に接続された調圧弁26cまたは26dが圧力供給状態に切り換えられ、且つ空気ポンプ36が駆動されることにより、2つの上腕用カフ20R、20Lおよび少なくとも一方の足首用カフ18の急速昇圧が開始される。続くSC2では、それらのカフ18、20のカフ圧PCがそれぞれ予め設定された目標圧迫圧 P_{CM} (たとえば、上腕用カフ20については180mmHg、足首用カフ18については240mmHg)以上となったか否かがそれぞれのカフ圧PCについて判断される。このSC2の判断が否定された場合は、上記SC1以下が繰り返し実行されることによりカフ圧PCの上昇が継続される。

【0065】そして、カフ圧PCの上昇により上記SC2の判断が肯定されると、続くSC3では、目標圧迫圧 P_{CM} に到達したカフ18、20に接続されている調圧弁26から順に徐速排圧状態に切り替えられて、その調圧弁26に接続されたカフ18、20内の圧力が予め定められた5mmHg/sec程度の緩やかな速度で下降させられる。そして、すべてのカフ圧PCについてSC2の判断が肯定されると空気ポンプ36も停止される。

【0066】次に、上腕血圧値決定手段72および足首血圧値決定手段82に相当するSC4の血圧値決定ルーチンが実行される。すなわち、脈波弁別回路32から逐次供給される脈波信号 SM が表す上腕脈波WAまたは足首脈波 WL の振幅が一拍毎に決定され、その振幅の変化に基づいて、よく知られたオシロメトリック方式の血圧値決定アルゴリズムに従って右上腕最高血圧値 $BP_{ASYS}(R)$ 、左上腕最高血圧値 $BP_{ASYS}(L)$ および右(左)足首最高血圧値 BP_{LSYS} 等が決定される。

【0067】次に、カフ圧制御手段60に相当するSC5において、徐速排圧状態にあった調圧弁26が急速排圧状態に切り換えられることにより、カフ18、20内

が急速に排圧させられる。

【0068】続いて足首上腕血圧指数算出手段84に相当するSC6が実行される。SC6では、SC4で決定された右足首最高血圧値BP_{LSYS}(R)または左足首最高血圧値BP_{LSYS}(L)が、SC4で決定された右上腕最高血圧値BP_{ASYS}(R)および左上腕最高血圧値BP_{ASYS}(L)のうちの高い方の値で割られることによりABIRまたはABILが算出され、その算出されたABIRまたはABILが表示器54に表示される。

【0069】続いて、図9の足首血圧測定ルーチンを説明する。図9の足首血圧測定ルーチンでは、まず、カフ圧制御手段60に相当するSD1乃至SD3が実行される。SD1では、図7のSB9で狭窄の疑いがあると判定された側の足首用カフ18に接続された調圧弁26cまたは26dが圧力供給状態に切り換えられ、且つ空気ポンプ36が駆動されることにより、少なくとも一方の足首用カフ18の急速昇圧が開始される。続くSD2では、そのカフ18のカフ圧PCが予め設定された目標圧迫圧P_{CM}(たとえば240mmHg)以上となったか否かが判断される。このSD2の判断が否定された場合は、上記SD1以下が繰り返し実行されることによりカフ圧PCの上昇が継続される。

【0070】そして、カフ圧PCの上昇により上記SD2の判断が肯定されると、続くSD3では、空気ポンプ36が停止させられるとともに調圧弁26が徐速排圧状態に切り替えられて、カフ18内の圧力が予め定められた5mmHg/sec程度の緩やかな速度で下降させられる。

【0071】次に、足首血圧値決定手段82に相当するSD4の血圧値決定ルーチンが実行される。すなわち、脈波弁別回路32から逐次供給される脈波信号SMが表す足首脈波WLの振幅が一拍毎に決定され、その振幅の変化に基づいて、よく知られたオシロメトリック方式の血圧値決定アルゴリズムに従って右(左)足首最高血圧値BP_{LSYS}、右(左)足首最低血圧値BP_{LDIA}、右(左)足首平均血圧値BP_{LMEAN}が決定される。

【0072】次に、カフ圧制御手段60に相当するSD5において調圧弁26が急速排圧状態に切り換えられることにより、カフ18内が急速に排圧させられる。

【0073】続くSD6では、SD4で決定された右(左)足首最高血圧値BP_{LSYS}等が表示器54に表示される。

【0074】上述のフローチャートに基づく実施例では、足首血圧測定装置42による足首血圧値BP_Lの測定に先立って、SB3、SB4、SB5(狭窄関連脈波情報決定手段)において、脈波弁別回路32c、32dによって抽出される足首脈波WLから下肢脈波伝播速度baPWV、U-time、%MAPが決定され、且つそれら下肢脈波伝播速度baPWV、U-time、%MAPが表示器54に表示されるので、それら下肢脈波伝播速度baPWV、U-time、%MAPから下肢動脈の狭窄の疑いがないと判断できる場合には、ABIを算

出するために足首血圧測定装置42による血圧測定を実行する必要がなくなる。従って、下肢動脈の狭窄を診断する際の患者の苦痛が少なくなる。

【0075】また、上述のフローチャートに基づく実施例では、SB6、SB9(予備判定手段76)によって狭窄の疑いがあると判定された場合には、自動的に足首血圧測定装置42および上腕血圧測定装置40による血圧測定が実行されて、ABIが算出される利点がある。

【0076】また、上述のフローチャートに基づく実施例では、SB2(正常範囲決定手段70)において、上肢脈波伝播速度hbPWVに基づいて図4の関係から下肢脈波伝播速度baPWVの正常範囲が決定される。そして、SB6(予備判定手段76)では、SB3(下肢脈波伝播速度情報算出手段68)において算出された下肢脈波伝播速度baPWVが正常範囲外であることを基づいて下肢動脈に狭窄の疑いがあると判定される。上記正常範囲は、測定毎に実際に測定された上肢脈波伝播速度hbPWVに基づいて決定されるので、測定された下肢脈波伝播速度baPWVが多数の患者に当たるよう設定された一般的な正常範囲に実際にあるか否かに基づいて下肢動脈の狭窄の疑いが判断される場合に比較して、下肢動脈における狭窄の有無の予備的判断がより精度よく行える。

【0077】また、上述のフローチャートに基づく実施例では、左下肢脈波WL_Lに基づく左下肢脈波伝播速度baPWV(L)、U-time(L)、%MAP(L)と右下肢脈波WL_Rに基づく右下肢脈波伝播速度baPWV(R)、U-time(R)、%MAP(R)との相違値(△PWV、△U-time、△%MAP)の少なくとも一つが基準値以上である場合には、SB8(予備判定手段76)において、狭窄の疑いがあると判定されるので、下肢動脈における狭窄の有無の予備的判断がより精度よく行える。

【0078】以上、本発明の一実施例を図面に基づいて説明したが、本発明は他の態様においても適用される。

【0079】例えば、前述した実施形態では、下肢脈波伝播速度baPWVの異常範囲は、正常範囲決定手段70により決定された正常範囲以外の範囲に決定されることにより、患者毎に決定されていたが、下肢脈波伝播速度baPWVの異常範囲は予め設定された一定値であってもよい。逆に、前述した実施形態では、U-timeおよび%MAPの異常範囲は予め決定されていたが、下肢脈波伝播速度baPWVの場合のように、上腕においてU-timeまたは%MAPを測定し、その上腕において測定したU-timeや%MAPに基づいて患者毎に下肢におけるU-timeまたは%MAPの異常範囲を決定してもよい。

【0080】また、前述した実施形態では、予備判定手段76は、下肢動脈に狭窄の疑いがある場合には、自動的に足首血圧測定装置42および/または上腕血圧測定装置40による血圧測定を実行させていたが、下肢動脈に狭窄の疑いがあると判定された場合に、単にその旨を示す文字または記号を表示器54に表示するのみでもよい。また、前述のフローチャートに基づく実施例のよう

に、狭窄関連脈波情報 (baPWV, U-time, %MAP) が表示器 5 4 に表示される場合には、その表示内容から操作者が下肢上肢血圧指数を測定する必要があるかを判断できるので、その場合には予備判定手段 7 6 は設けられなくてもよい。

【0081】また、前述した実施形態では、上腕血圧測定装置 4 0 に備えられた脈波弁別回路 3 2 が上肢脈波検出装置としても機能し、足首血圧測定装置 4 2 に備えられた脈波弁別回路 3 2 が下肢脈波検出装置としても機能していたが、それら血圧測定装置 4 0, 4 2 の脈波弁別回路 3 2 とは別に、脈波を検出するためにのみ上肢または下肢に脈波検出装置が装着されてもよい。脈波検出装置としては、たとえば、酸素飽和度測定用の光電脈波検出プローブ、桡骨動脈などの所定の動脈を表皮上からを押圧して圧脈波を検出する形式の圧脈波センサ、腕や指先などのインピーダンスを電極を通して検出するインピーダンス脈波センサ、脈拍検出などのために指尖部などに装着される光電脈波センサなどを用いることができる。

【0082】また、前述した実施形態では、心音マイク 4 4 と上腕用カフ 2 0 との間の上腕脈波伝播速度情報を算出する例を説明したが、他の 2 部位間の上腕脈波伝播速度情報が算出されてもよい。たとえば、心臓は生体中心線上に位置しないので左右の上腕 1 4 に巻回された上腕用カフ 2 0 は心臓からの距離が異なる。そこで、左右の上腕用カフ 2 0 内に発生する上腕脈波 WA_R , WA_L の時間差から上腕脈波伝播速度情報を算出してもよい。或いは、腕の指尖部に光電脈波センサが装着され、心臓（または上腕）と指先との間で上腕脈波伝播速度情報を算出されてもよい。

【0083】また、前述した実施形態では、足首用カフ 1 8 と上腕用カフ 2 0 との間で下肢脈波伝播速度情報を算出する例を説明したが、心音マイク 4 4 と足首用カフ 1 8 との間の下肢脈波伝播速度情報を算出されてもよい。

【0084】以上、本発明の実施形態を図面に基づいて詳細に説明したが、これはあくまでも一実施形態であり、本発明は当業者の知識に基づいて種々の変更、改良を加えた態様で実施することができる。

【図面の簡単な説明】

【図1】本発明が適用された足首上腕血圧測定装置の構成を説明するブロック図である。

【図2】図1の演算制御装置の制御機能のうち、ABIの

測定が必要なほどに狭窄の疑いがあるか否かを判定するための予備的な診断に関する機能の要部を説明する機能ブロック線図である。

【図3】足首脈波WLを例示する図である。

【図4】心臓と上腕との間で算出された上肢脈波伝播速度hbPWVと、心臓と足首との間で算出された下肢脈波伝播速度baPWVとの間の関係を例示する図である。

【図5】図1の演算制御装置の制御機能のうち、図2に示す機能が実行されることによって下肢動脈に狭窄の疑いがあると判定された場合に実行される機能の要部を説明する機能ブロック線図である。

【図6】図2および図5に示した演算制御装置の制御機能の要部をさらに具体的に説明するためのフローチャートであって、予備判定のための信号を読み込む信号読み込みルーチンである。

【図7】図2および図5に示した演算制御装置の制御機能の要部をさらに具体的に説明するためのフローチャートであって、図6で読み込んだ信号に基づいて予備判定を行う予備判定ルーチンである。

【図8】図2および図5に示した演算制御装置の制御機能の要部をさらに具体的に説明するためのフローチャートであって、ABI測定ルーチンである。

【図9】図2および図5に示した演算制御装置の制御機能の要部をさらに具体的に説明するためのフローチャートであって、足首血圧測定ルーチンである。

【符号の説明】

1 0 : 足首上腕血圧指数測定装置（下肢上肢血圧指数測定装置）

3 2 : 脈波弁別回路（下肢脈波検出装置、上肢脈波検出装置）

4 0 : 上腕血圧測定装置（上肢血圧測定装置）

4 2 : 足首血圧測定装置（下肢血圧測定装置）

6 2 : 上昇特徴値決定手段（狭窄関連脈波情報決定手段）

6 4 : 先鋭度算出手段（狭窄関連脈波情報決定手段）

6 6 : 上肢脈波伝播速度情報算出手段

6 8 : 下肢脈波伝播速度情報算出手段（狭窄関連脈波情報決定手段）

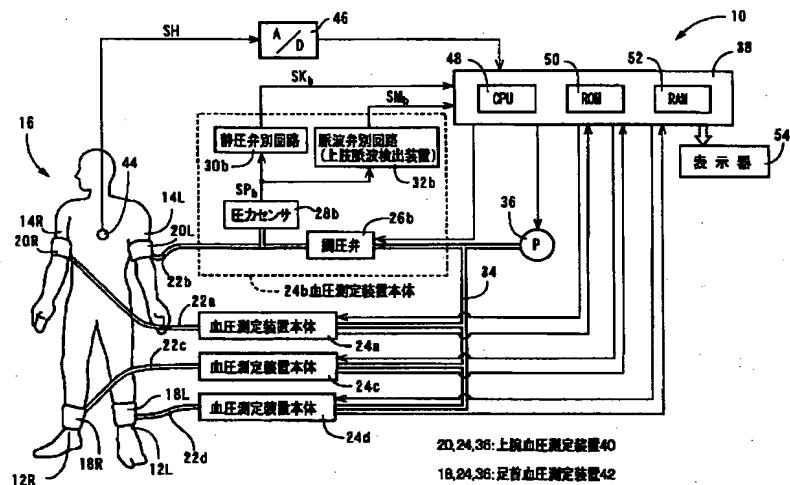
7 0 : 正常範囲決定手段

7 6 : 予備判定手段

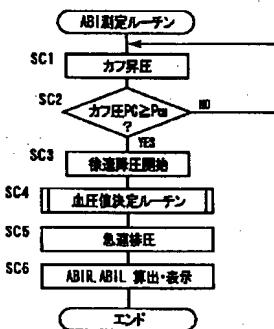
7 8 : ABI測定起動手段（血圧測定起動手段）

8 4 : 足首上腕血圧指数算出手段（下肢上肢血圧指数算出手段）

【図 1】

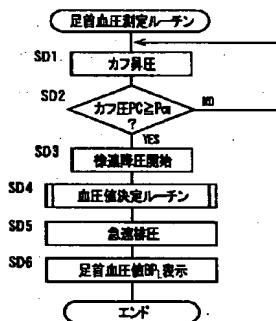
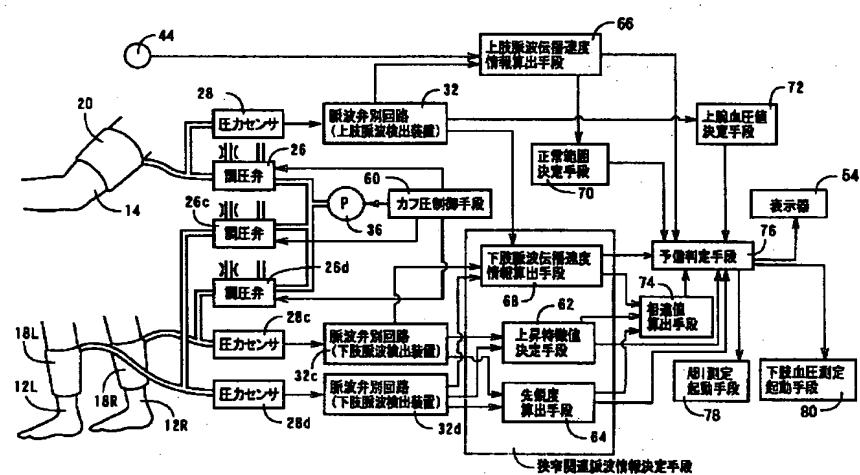


[図 8]

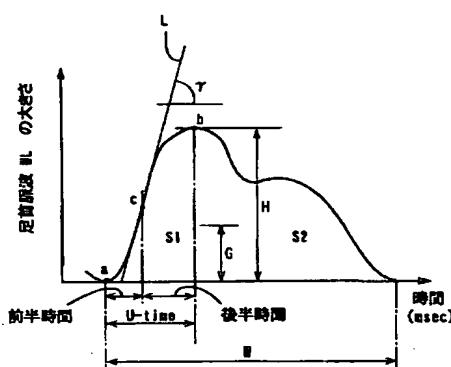


[図9]

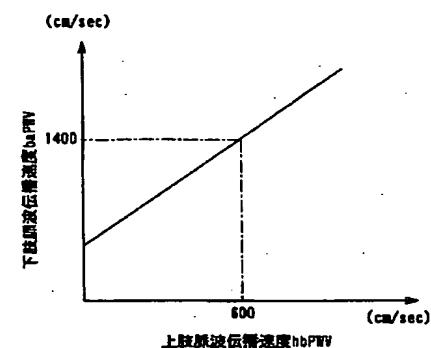
【図2】



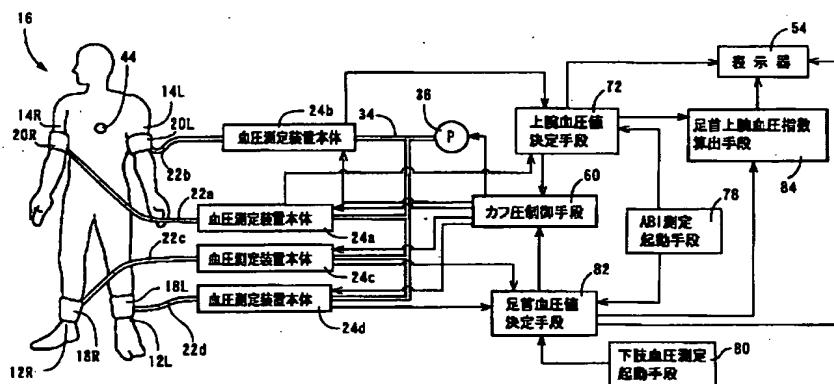
【図3】



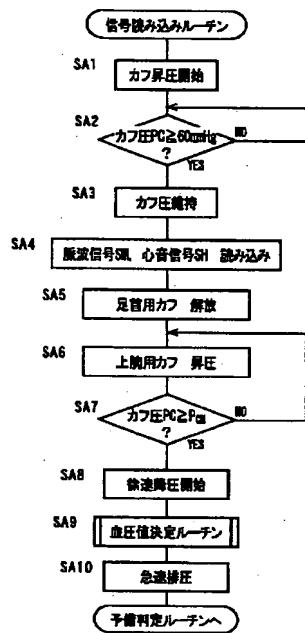
【図4】



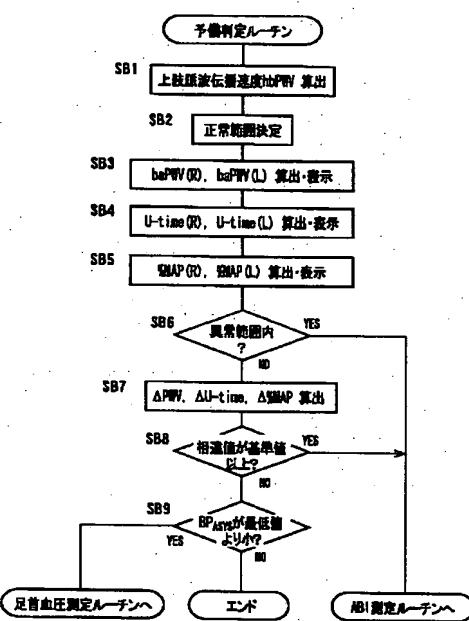
【図5】



【図 6】



【図 7】



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CLAIMS

[Claim(s)]

[Claim 1] The membrum-inferius blood-pressure-measurement equipment which measures the membrum-inferius blood-pressure value which is a blood-pressure value in this membrum inferius using the cuff wound around a living body's membrum inferius, The upper extremity blood-pressure-measurement equipment which measures the upper extremity blood-pressure value which is a blood-pressure value in this upper extremity using the cuff wound around this living body's upper extremity, It is based on the membrum-inferius blood-pressure value measured by this membrum-inferius blood-pressure-measurement equipment, and the upper extremity blood-pressure value measured by this upper extremity blood-pressure-measurement equipment. The membrum-inferius pulse wave detection equipment with which this living body's membrum inferius is equipped and which is a membrum-inferius upper extremity blood-pressure characteristic measuring device equipped with a membrum-inferius upper extremity blood-pressure characteristic calculation means to compute a membrum-inferius upper extremity blood-pressure characteristic, and detects a membrum-inferius pulse wave, The membrum-inferius upper extremity blood-pressure characteristic measuring device characterized by including a constriction related pulse wave information decision means to determine the constriction related pulse wave information changed in relation to the constriction of the membrum inferius, based on the membrum-inferius pulse wave detected by said membrum-inferius pulse wave detection equipment.

[Claim 2] A preliminary judging means to judge with the misgiving of a constriction being in an artery of lower extremity based on the constriction related pulse wave information determined by said constriction related pulse wave information decision means being the value of abnormality within the limits set up beforehand, The membrum-inferius upper extremity blood-pressure characteristic measuring device according to claim 1 characterized by including further a blood-pressure-measurement starting means to perform blood pressure measurement with said membrum-inferius blood-pressure-measurement equipment and said upper extremity blood-pressure-measurement equipment when judged with there being misgiving of a constriction with this preliminary judging means.

[Claim 3] The membrum-inferius upper extremity blood-pressure characteristic measuring device according to claim 1 or 2 characterized by including at least one of the following three means as said constriction related pulse wave information decision means.

(1) the membrum-inferius pulse-wave-velocity information calculation means (2) compute the membrum-inferius pulse-wave-velocity information relevant to the rate at which a pulse wave spreads said membrum inferius based on the membrum-inferius pulse wave detected by said membrum-inferius pulse-wave detection equipment -- the acutance-of-image calculation means (3) compute the acutance of image of the membrum-inferius pulse wave detected by said membrum-inferius pulse-wave detection equipment -- the rise description value decision means [a claim 4] determine the rise description value which is the description value of the membrum-inferius pulse wave detected by said membrum-inferius pulse-wave detection equipment for a rising limb As said constriction related pulse wave information calculation means, it is based on the membrum-inferius pulse wave detected by said membrum-inferius pulse wave detection equipment. It is a membrum-inferius upper extremity blood-pressure characteristic measuring device including a membrum-inferius pulse-wave-velocity information calculation means to compute the membrum-inferius pulse-wave-velocity information relevant to the rate at which a pulse wave spreads said membrum inferius according to claim 1 or 2. The upper extremity pulse wave detection equipment with which said living body's upper extremity is equipped and which detects an upper extremity pulse wave, An upper extremity pulse-wave-velocity information calculation means to compute the upper extremity pulse-wave-velocity information relevant to the rate at which a pulse wave spreads said upper

extremity based on the upper extremity pulse wave detected by this upper extremity pulse wave detection equipment, A normal-range decision means to determine the normal range of membrum-inferius pulse-wave-velocity information from the relation memorized beforehand based on the upper extremity pulse-wave-velocity information computed by this upper extremity pulse-wave-velocity information calculation means, The membrum-inferius pulse-wave-velocity information computed by said membrum-inferius pulse-wave-velocity information calculation means The membrum-inferius upper extremity blood-pressure characteristic measuring device characterized by including further a preliminary judging means to judge with the misgiving of a constriction being in an artery of lower extremity, based on being outside the normal range determined by said normal-range decision means.

[Claim 5] It is the membrum-inferius upper extremity blood-pressure characteristic measuring device which it is a membrum-inferius upper extremity blood-pressure characteristic measuring device according to claim 1 or 2, and the membrum inferius of right and left of said living body is equipped with said membrum-inferius pulse wave detection equipment, respectively, and is characterized by said constriction related pulse wave information decision means being what determines said constriction related pulse wave information based on a left lower extremity pulse wave and a right lower extremity pulse wave, respectively.

[Claim 6] The membrum-inferius upper extremity blood-pressure characteristic measuring device according to claim 5 characterized by including a preliminary judging means to judge with the misgiving of a constriction being in an artery of lower extremity in being beyond the reference value with which the difference value of the constriction related pulse wave information based on the left lower extremity pulse wave determined in said constriction related pulse wave information decision means, respectively and the constriction related pulse wave information based on a right lower extremity pulse wave was set up beforehand.

[Translation done.]

* NOTICES *

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the membrum-inferius upper extremity blood-pressure characteristic measuring device which measures a membrum-inferius upper extremity blood-pressure characteristic.

[0002]

[Description of the Prior Art] Usually, the blood-pressure value (henceforth a membrum-inferius blood-pressure value) in the membrum inferius is higher than the blood-pressure value (henceforth an upper extremity blood-pressure value) in an upper extremity. However, if a constriction is in the artery of the membrum inferius, a membrum-inferius blood-pressure value will become lower than an upper extremity blood-pressure value. In order to diagnose the constriction of an artery of lower extremity using this, the membrum-inferius upper extremity blood-pressure characteristic measuring device which computes the membrum-inferius upper extremity blood-pressure characteristic which is the ratio of a membrum-inferius blood-pressure value and an upper extremity blood-pressure value is proposed. For example, the equipment indicated by the patent No. 3027750 official report is it.

[0003] In order to compute a membrum-inferius upper extremity blood-pressure characteristic, a membrum-inferius blood-pressure value and an upper extremity blood-pressure value must be measured. In order to measure a membrum-inferius blood-pressure value and an upper extremity blood-pressure value, generally the blood-pressure-measurement equipment of the format which measures a blood-pressure value based on the signal generated in a cuff in the process in which a living body's membrum inferius or upper extremity is made to carry out **** change of winding and the compression pressure force of the cuff for a cuff is used. The blood-pressure-measurement equipment of a format using a cuff is because a reliable blood-pressure value is acquired. The membrum-inferius upper extremity blood-pressure characteristic computed based on the membrum-inferius blood-pressure value and upper extremity blood-pressure value which were measured using the cuff is reliable, and can diagnose the constriction of an artery of lower extremity with a sufficient precision.

[0004]

[Problem(s) to be Solved by the Invention] However, to measure a blood-pressure value with the blood-pressure-measurement equipment of a format using a cuff, it is necessary to carry out the pressure up of the compression pressure force of a cuff to the target pressure force once set as the pressure higher than a highest-blood-pressure value. Moreover, to measure a membrum-inferius blood-pressure value since the highest-blood-pressure value in the membrum inferius is higher than the highest-blood-pressure value in an upper extremity if it is a normal person, it is necessary to carry out the pressure up of the compression pressure force of a cuff to the target pressure force still higher than the case where an upper extremity blood-pressure value is measured. For example, with membrum-inferius blood-pressure-measurement equipment, the target pressure force is set as 240mmHg extent to the target pressure force having common 180mmHg extent with upper extremity blood-pressure-measurement equipment. Therefore, when measuring a membrum-inferius blood-pressure value, there was a problem that the pain given to a patient was comparatively large.

[0005] The place which succeeded in this invention against the background of the above situation, and is made into the purpose has the pain of the patient at the time of diagnosing the constriction of an artery of lower extremity in offering few membrum-inferius upper extremity blood-pressure characteristic measuring devices.

[0006]

[Means for Solving the Problem] this invention person found out that there was information (let this be constriction related pulse wave information) changed in relation to the constriction of an artery of lower extremity also to the information acquired from a membrum-inferius pulse wave, as a result of repeating examination, in order to attain the above-mentioned purpose. And based on the constriction related pulse wave information, the preliminary diagnosis about the constriction of an artery of lower extremity was performed, and when it was suspected that a constriction is in an artery of lower extremity and the membrum-inferius upper extremity blood-pressure characteristic was computed, it resulted in the idea that pain of the patient at the time of diagnosing the constriction of an artery of lower extremity can be lessened. This invention is made based on the starting thought.

[0007] Namely, invention concerning claim 1 for attaining said purpose The membrum-inferius blood-pressure-measurement equipment which measures the membrum-inferius blood-pressure value which is a blood-pressure value in the membrum inferius using the cuff wound around a living body's membrum inferius, The upper extremity blood-pressure-measurement equipment which measures the upper extremity blood-pressure value which is a blood-pressure value in the upper extremity using the cuff wound around the living body's upper extremity, It is based on the membrum-inferius blood-pressure value measured by the membrum-inferius blood-pressure-measurement equipment, and the upper extremity blood-pressure value measured by the upper extremity blood-pressure-measurement equipment. The membrum-inferius pulse wave detection equipment with which said living body's membrum inferius is equipped and which is a membrum-inferius upper extremity blood-pressure characteristic measuring device equipped with a membrum-inferius upper extremity blood-pressure characteristic calculation means to compute a membrum-inferius upper extremity blood-pressure characteristic, and detects a membrum-inferius pulse wave, It is characterized by including a constriction related pulse wave information decision means to determine the constriction related pulse wave information changed in relation to the constriction of the membrum inferius, based on the membrum-inferius pulse wave detected by the membrum-inferius pulse wave detection equipment.

[0008] In order to compute a membrum-inferius upper-extremity blood-pressure characteristic, it becomes unnecessary to perform blood pressure measurement by membrum-inferius blood-pressure-measurement equipment, when it can be judged from the constriction related pulse-wave information that there is no misgiving of the constriction of an artery of lower extremity, if constriction related pulse-wave information is determined from the membrum-inferius pulse wave which is detected by the constriction related pulse wave information decision means with membrum-inferius pulse wave detection equipment in advance of measurement of the membrum-inferius blood-pressure value by membrum-inferius blood-pressure-measurement equipment according to this invention. Therefore, the pain of the patient at the time of diagnosing the constriction of an artery of lower extremity decreases. In addition, the above-mentioned decision may be judged automatically and people may judge it.

[0009] Moreover, invention concerning claim 2 for attaining said purpose A preliminary judging means to judge with the misgiving of a constriction being in an artery of lower extremity based on the constriction related pulse wave information determined by said constriction related pulse wave information decision means being the value of abnormality within the limits set up beforehand, When judged with there being misgiving of a constriction with the preliminary judging means, it is characterized by including further a blood-pressure-measurement starting means to perform blood pressure measurement with said membrum-inferius blood-pressure-measurement equipment and said upper extremity blood-pressure-measurement equipment.

[0010] When it is judged with there being misgiving of a constriction by the preliminary judging means according to this invention, blood pressure measurement by membrum-inferius blood-pressure-measurement equipment and upper extremity blood-pressure-measurement equipment is automatically performed by the blood-pressure-measurement starting means, and there is an advantage by which a membrum-inferius upper extremity blood-pressure characteristic is computed.

[0011] Moreover, invention concerning claim 3 for attaining said purpose is characterized by including at least one of the following three means as said constriction related pulse wave information decision means.

(1) the membrum-inferius pulse-wave-velocity information calculation means (2) compute the membrum-inferius pulse-wave-velocity information relevant to the rate at which a pulse wave spreads said membrum inferius based on the membrum-inferius pulse wave detected by said membrum-inferius pulse-wave detection equipment -- the acutance-of-image calculation means (3) compute the acutance of image of the membrum-inferius pulse wave detected by said membrum-inferius pulse-wave detection equipment -- the rise description value decision means [0012] determine the rise description value which is the

description value of the membrum-inferius pulse wave detected by said membrum-inferius pulse-wave detection equipment for a rising limb Moreover, invention concerning claim 4 for attaining said purpose As said constriction related pulse wave information calculation means, it is based on the membrum-inferius pulse wave detected by said membrum-inferius pulse wave detection equipment. It is a membrum-inferius upper extremity blood-pressure characteristic measuring device including a membrum-inferius pulse-wave-velocity information calculation means to compute the membrum-inferius pulse-wave-velocity information relevant to the rate at which a pulse wave spreads said membrum inferius according to claim 1 or 2. The upper extremity pulse wave detection equipment with which said living body's upper extremity is equipped and which detects an upper extremity pulse wave, An upper extremity pulse-wave-velocity information calculation means to compute the upper extremity pulse-wave-velocity information relevant to the rate at which a pulse wave spreads said upper extremity based on the upper extremity pulse wave detected by the upper extremity pulse wave detection equipment, A normal-range decision means to determine the normal range of membrum-inferius pulse-wave-velocity information from the relation memorized beforehand based on the upper extremity pulse-wave-velocity information computed by the upper extremity pulse-wave-velocity information calculation means, Membrum-inferius pulse-wave-velocity information computed by said membrum-inferius pulse-wave-velocity information calculation means is characterized by including further a preliminary judging means to judge with the misgiving of a constriction being in an artery of lower extremity, based on being outside the normal range determined by said normal-range decision means.

[0013] According to this invention, the normal range of membrum-inferius pulse-wave-velocity information is determined from the relation beforehand memorized by the normal-range decision means based on upper extremity pulse-wave-velocity information. And it is judged with the misgiving of a constriction being in an artery of lower extremity based on the membrum-inferius pulse-wave-velocity information computed by the membrum-inferius pulse-wave-velocity information calculation means being outside a normal range by the preliminary judging means. Since the above-mentioned normal range is determined based on the upper extremity pulse-wave-velocity information actually measured for every measurement, as compared with the case where the misgiving of the constriction of an artery of lower extremity is judged based on whether it is in the general normal range set up so that the actually measured membrum-inferius pulse-wave-velocity information might be applied to many patients, preliminary decision of the existence of the constriction in an artery of lower extremity can perform it with a more sufficient precision.

[0014] Moreover, invention concerning claim 5 for attaining said purpose is a membrum-inferius upper extremity blood-pressure characteristic measuring device according to claim 1 or 2, the membrum inferius of right and left of said living body is equipped with said membrum-inferius pulse wave detection equipment, respectively, and said constriction related pulse wave information decision means is characterized by being what determines said constriction related pulse wave information based on a left lower extremity pulse wave and a right lower extremity pulse wave, respectively.

[0015] According to this invention, by comparing the constriction related pulse wave information based on a left lower extremity pulse wave with the constriction related pulse wave information based on a right lower extremity pulse wave, when both difference is great, a constriction is in the membrum inferius of one of right and left, and since it can judge that both difference may benefit that constriction large, the preliminary diagnosis of the existence of the constriction in an artery of lower extremity can carry out with a more sufficient precision.

[0016] Moreover, invention concerning claim 6 for attaining said purpose is a membrum-inferius upper-extremity blood-pressure characteristic measuring device according to claim 5, and when it is beyond the reference value with which the difference value of the constriction related pulse-wave information based on the left lower extremity pulse wave determined in said constriction related pulse-wave information decision means, respectively and the constriction related pulse-wave information based on a right lower extremity pulse wave was set up beforehand, it is characterized by to include a preliminary judging means judge with the misgiving of a constriction being in an artery of lower extremity.

[0017] Since according to this invention it is judged with there being misgiving of a constriction by the preliminary judging means when the difference value of the constriction related pulse wave information based on a left lower extremity pulse wave and the constriction related pulse wave information based on a right lower extremity pulse wave is beyond a reference value, preliminary decision of the existence of the constriction in an artery of lower extremity can carry out with a more sufficient precision.

[0018]

[The gestalt of suitable implementation of invention] Hereafter, 1 operation gestalt of this invention is

explained to a detail based on a drawing. Drawing 1 is a block diagram explaining the configuration of the ankle overarm blood-pressure characteristic measuring device 10 with which this invention was applied. That is, the ankle overarm blood-pressure characteristic measuring device 10 of drawing 1 is a membrum-inferius upper extremity blood-pressure characteristic measuring device with which the ankle 12 (right leg neck 12R and left leg neck 12L) was chosen as membrum inferius, and the overarm 14 (right upper arm 14R and left upper arm 14L) was chosen as an upper extremity. in addition, the measurement by this ankle overarm blood-pressure characteristic measuring device 10 -- an overarm 14 and an ankle 12 -- abbreviation -- a patient 16 is measured at least for proneness in the state of either - lateral position and a lateral position so that it may become the same height.

[0019] The cuffs 18R and 18L for ankles are wound around Ankles 12R and 12L, respectively, and the cuffs 20R and 20L for overarms are wound around Overarms 14R and 14L, respectively. These cuffs 18 and 20 are tourniquet which presses the part currently wound, and have rubber bag manufacture in the bag outside band-like which consists of a material without the extensibility of cloth or polyester.

[0020] The cuffs 20R and 20L for overarms are connected to body of blood-pressure-measurement equipment 24a, and b through Piping 22a and 22b, respectively, and the cuffs 18R and 18L for ankles are connected to body of blood-pressure-measurement equipment 24c, and d through piping 22c and d, respectively.

[0021] Since these four bodies of blood-pressure-measurement equipment 24a, and b, c and d have the same configuration, they explain the configuration of the body 24 of blood-pressure-measurement equipment by making into an example body of blood-pressure-measurement equipment 24b connected with cuff 20L for overarms. Body of blood-pressure-measurement equipment 24b is equipped with pressure regulating valve 26b, pressure-sensor 28b, static pressure discriminator 30b, and pulse wave discriminator 32b, and said piping 22b is connected to pressure-sensor 28b and pressure regulating valve 26b. Moreover, pressure regulating valve 26b is connected to the air pump 36 through piping 34.

[0022] The pressure supply condition of permitting the above-mentioned pressure regulating valve 26b supplying the pressure air generated by the air pump 36 into cuff 20L for overarms, The pressure maintenance condition of maintaining the pressure in cuff 20L for overarms, the **** exhaust-gas-pressure condition which carries out exhaust gas pressure of the pressure in cuff 20L for overarms gradually at the rate of predetermined by controlling the opening of an electric bulb, And it changes to four conditions of the rapid exhaust-gas-pressure condition which carries out exhaust gas pressure of the inside of cuff 20L for overarms quickly.

[0023] Pressure-sensor 28b supplies the pressure signal SPb with which the pressure in cuff 20L for overarms is detected, and the pressure is expressed, respectively to static pressure discriminator 30b and pulse wave discriminator 32b. Static pressure discriminator 30b is equipped with a low pass filter, and supplies it to an arithmetic sequence unit 38 through the A/D converter which discriminates from the cuff pressure signal SKb showing steady pressure PCb, i.e., cuff pressure, contained in the pressure signal SPb, and does not illustrate the cuff pressure signal SKb.

[0024] Pulse wave discriminator 32b is equipped with a band pass filter, and supplies it to an arithmetic sequence unit 38 through the A/D converter which discriminates from the pulse wave signal SMb which is the oscillating component of the pressure signal SPb in frequency, and does not illustrate the pulse wave signal SMb. Since this pulse wave signal SMb expresses the overarm pulse wave WAL from the artery of left upper arm 14L pressed by cuff 20L for overarms, pulse wave discriminator 32b is functioning as upper extremity pulse wave detection equipment. Similarly moreover, pulse wave discriminator 32 of body of blood-pressure-measurement equipment 24a a It functions as upper extremity pulse wave detection equipment which discriminates from the pulse wave signal SMA showing the overarm pulse wave WAR from the artery of right upper arm 14R. Pulse wave discriminator 32 of body of blood-pressure-measurement equipment 24c c It functions as membrum-inferius pulse wave detection equipment which discriminates from the pulse wave signal SMc showing the ankle pulse wave WLR from the artery of right leg neck 12R. 32d of pulse wave discriminators of 24d of bodies of blood-pressure-measurement equipment It functions as membrum-inferius pulse wave detection equipment which discriminates from the pulse wave signal SMd showing the ankle pulse wave WLL from the artery of left leg neck 12L.

[0025] In addition, overarm blood-pressure-measurement equipment 40L is constituted by cuff 20 for overarms L, body of blood-pressure-measurement equipment 24b, and the air pump 36. Similarly, overarm blood-pressure-measurement equipment 40R is constituted by cuff 20 for overarms R, body of blood-pressure-measurement equipment 24a, and the air pump 36, ankle blood-pressure-measurement equipment 42R is constituted by cuff 18 for ankles R, body of blood-pressure-measurement equipment

24c, and the air pump 36, and ankle blood-pressure-measurement equipment 42L is constituted by cuff 18 for ankles L, 24d of bodies of blood-pressure-measurement equipment, and the air pump 36.

[0026] The predetermined part on a living body's thorax epidermis is equipped with the heartbeat microphone 44, and it detects and outputs the cardiac correspondence number SH showing a heartbeat. The cardiac correspondence number SH outputted from the heartbeat microphone 44 is supplied to an arithmetic sequence unit 38 through A/D converter 46. Since the heartbeat which the above-mentioned cardiac correspondence number SH expresses is a heartbeat synchronizing signal generated synchronizing with a living body's heartbeat, the heartbeat microphone 44 which outputs the cardiac correspondence number SH is functioning as heartbeat synchronizing signal detection equipment.

[0027] The above-mentioned arithmetic sequence unit 38 consists of so-called microcomputers equipped with CPU48, ROM50, RAM52, the I/O Port that is not illustrated. CPU48 By performing signal processing, using the memory storage function of RAM52 for ROM50 according to the program memorized beforehand While outputting a driving signal from an I/O Port and controlling the pressure regulating valve 26 within an air pump 36 and the body 24 of blood-pressure-measurement equipment Calculation of an ankle overarm blood-pressure characteristic (Ankle/Arm Blood Pressure =ABI) etc. is performed, and the computed ABI is displayed on a drop 54.

[0028] It is a functional block diagram explaining the important section of the function about the preliminary diagnosis for judging whether there is any misgiving of a constriction, so that drawing 2 needs measurement of ABI among the control functions of the above-mentioned arithmetic sequence unit 38.

[0029] The cuff pressure control means 60 is set to blood pressure measurement. Four pressure regulating valve 26a connected to an air pump 36 and it, and b, c and d are controlled. The cuff pressures PCa, PCb, PCc, and PCd of the cuff 20 for overarms, and the cuff 18 for ankles To the predetermined target pressure force value PCM (about 180mmHg extent and the cuff 18 for ankles, it is [cuff / 20 / for overarms] the pressure value of 240mmHg extent), a rapid pressure up is carried out and **** pressure lowering is carried out at the rate of 5 mmHg/sec extent after that. Moreover, after controlling four pressure regulating valve 26a connected to an air pump 36 and it, and b, c and d and carrying out the pressure up of the cuff pressures PCa, PCb, PCc, and PCd to predetermined pulse wave *****, the pressure is made to hold fixed time in detection of the pulse wave for computing constriction related pulse wave information. The above-mentioned pulse wave ***** is the pressure which is generated in signal strength with the pulse wave it is lower than a general lowest-blood-pressure value, and sufficient which the pressure oscillatory wave generated in the artery under the cuff in cuffs 18 and 20 is transmitted, and expresses the pressure oscillatory wave to cuffs 18 and 20, for example, is 60mmHg(s).

[0030] the rise description value decision means 62 determines the rise description value showing the description for the rising limb of the left leg neck pulse wave WLL extracted by the right leg neck pulse wave WLR and 32d of pulse wave discriminators extracted by pulse wave discriminator 32c in the condition that the cuff 18 for ankles is maintained by said pulse wave ***** by the cuff pressure control means 60 from a point to a peak namely, -- starting, respectively. Drawing 3 is drawing which illustrates the ankle pulse wave WL, and what is shown in drawing 3 is contained in the rise description value. namely, inclination [of the tangent L in U-time (msec) computed as a period when it starts at and the ankle pulse wave WL from Point a to Peak b goes up, and the point c, i.e., the point inclining / maximum, that start and the rate of increase serves as max from a point a even at Peak b / gamma -- it starts and a ratio with time amount etc. is contained in a rise description value time amount and the second half the first-half time amount from a point a to the point c inclining / maximum /, the second-half time amount from the point c inclining / maximum / to a peak b, and its first half. Since the ankle pulse wave WLR and WLL are in the inclination to start and for the inclination of a part to become gently-sloping so that extent of the constriction in the membrum inferius of the upstream of Ankles 12R and 12L is large, if a constriction is in the membrum inferius of the upstream of Ankles 12R and 12L, the rise description value will change in relation to the constriction. For example, U-time becomes so long that extent of the constriction in the upstream is large. Therefore, the rise description value computed from the ankle pulse wave WLR and WLL is constriction related pulse wave information, and the rise description value decision means 62 functions as a constriction related pulse wave information decision means.

[0031] The acutance-of-image calculation means 64 computes the acutance of image of the left leg neck pulse wave WLL extracted by the right leg neck pulse wave WLR and 32d of pulse wave discriminators extracted by pulse wave discriminator 32c in the condition that the cuff 18 for ankles is maintained by said pulse wave ***** by the cuff pressure control means 60, respectively. The above-mentioned acutance of image is a value to the upper part of a pulse wave which sharpens and shows condition. For

example By breaking the pulse wave area S computed by integrating with the ankle pulse wave WL of the section for one beat shown in drawing 3 (addition) by the product (WxH) of peak height H and the pulse period W namely, $S/(WxH)$ -- the normalization pulse wave area VR computed by performing an operation -- I/W which normalized the width-of-face dimension I of what normalized the area S1 of the first portion to the highest peak b or the area S2 of the second half section after the highest peak b, and the height equivalent to $Hx(2/3)$ is acutance of image. Moreover, the above-mentioned normalization pulse wave area VR is also called %MAP, and can be computed also as a rate ($= 100xH/G$) of peak height H, i.e., height G of the center-of-gravity location of the pulse wave area S to pulse pressure. an ankle 12 -- if a constriction is in the membrum inferius of the upstream of R and L -- the amplitude of the ankle pulse wave WLR and WLL -- weak -- becoming -- the upper part of a pulse wave -- it sharpens and condition becomes blunt. That is, if a constriction is in the membrum inferius of the upstream of Ankles 12R and 12L, since the above-mentioned acutance of image will become small, the acutance of image computed from the ankle pulse wave WLR and WLL is constriction related pulse wave information, and the acutance-of-image calculation means 64 functions as a constriction related pulse wave information decision means.

[0032] The upper extremity pulse-wave-velocity information calculation means 66 computes the upper extremity pulse-wave-velocity information relevant to the rate at which a pulse wave spreads between predetermined 2 parts containing an upper extremity (however, the membrum inferius is not included). The two above-mentioned part is the part and the heart which are equipped with the cuff 20 for overarms. Moreover, the upper extremity pulse wave velocity which is a rate at which a pulse wave spreads the upper extremity pulse wave propagation time which is the time amount to which a pulse wave spreads an upper extremity, and an upper extremity is contained in upper extremity pulse-wave-velocity information. In considering as the part and the heart with which the cuff 20 for overarms is equipped with the two above-mentioned part For example, the time of the predetermined parts (start point of I sound etc.) of the heartbeat detected with the heartbeat microphone 44 repeated periodically occurring, Time difference with the time of the predetermined parts (starting point etc.) of the overarm pulse wave WA extracted by the pulse wave discriminator 32 which functions as upper extremity pulse wave detection equipment repeated periodically occurring is computed as the upper extremity pulse wave propagation time hbDT (sec). Or the upper extremity pulse wave velocity hbPWV (cm/sec) is computed from the formula 1 beforehand memorized by ROM50 based on the upper extremity pulse wave propagation time hbDT. In addition, in a formula 1, L1 (cm) is the distance to the part where it is equipped with the cuff 20 for overarms through a main artery from an aortic valve, and the constant value beforehand determined based on the experiment is used.

(Formula 1) $hbPWV = L1/hbDT$ [0033] The membrum-inferius pulse-wave-velocity information calculation means 68 computes the membrum-inferius pulse-wave-velocity information relevant to the rate at which a pulse wave spreads between predetermined 2 parts containing the membrum inferius. The two above-mentioned part is a part where it is equipped with the cuffs 18R or 18L for the heart and ankles. Moreover, the membrum-inferius pulse wave propagation time and membrum-inferius pulse wave velocity are contained in membrum-inferius pulse-wave-velocity information like upper extremity pulse-wave-velocity information. If a constriction is in the membrum inferius between the above-mentioned 2 parts, since the membrum-inferius pulse wave propagation time will become long and membrum-inferius pulse wave velocity will become slow, membrum-inferius pulse-wave-velocity information is constriction related pulse wave information, and the membrum-inferius pulse-wave-velocity information calculation means 68 functions as a constriction related pulse wave information decision means. In considering as the part where the cuff 18 for the heart and ankles is equipped with the two above-mentioned part For example, the time of the predetermined parts (start point of I sound etc.) of the heartbeat detected with the heartbeat microphone 44 repeated periodically occurring, Time difference with the time of the ankle pulse wave WLR extracted by the pulse wave discriminators 32c and 32d which function as membrum-inferius pulse wave detection equipment, and the predetermined parts (starting point etc.) of WLL repeated periodically occurring is computed as the membrum-inferius pulse wave propagation time baDT (sec). The membrum-inferius pulse wave velocity baPWV (cm/sec) is computed from the formula 2 beforehand memorized by ROM50 based on the membrum-inferius pulse wave propagation time baDT. In addition, in a formula 2, L2 (cm) is the distance to the part where it is equipped with the cuff 18 for ankles from an aortic valve, and the constant value beforehand determined based on the experiment is used.

(Formula 2) $baPWV = L2/baDT$ [0034] The normal-range decision means 70 determines the normal range of membrum-inferius pulse-wave-velocity information based on the upper extremity pulse-wave-velocity information computed by the upper extremity pulse-wave-velocity information calculation means

66 from the relation beforehand memorized between upper extremity pulse-wave-velocity information and membrum-inferius pulse-wave-velocity information. the upper extremity pulse-wave-velocity information actually computed by the upper extremity pulse-wave-velocity information calculation means 68, having assumed that there was no constriction in an upper extremity since fixed proportionality was materialized between upper extremity pulse-wave-velocity information and membrum-inferius pulse-wave-velocity information when there was no constriction in an upper extremity and the membrum inferius -- using -- the account of a top -- the above-mentioned normal range is determined from the proportionality memorized beforehand. Drawing 4 is drawing which illustrates the relation between the membrum-inferius pulse wave velocity baPWV computed between the upper extremity pulse wave velocity hbPWV, the hearts, and the ankles which were computed between the heart and an overarm. When using the relation shown in drawing 4 as relation memorized beforehand, the range of -10%+10% of the membrum-inferius pulse wave velocity baPWV is determined as a normal range focusing on the membrum-inferius pulse wave velocity baPWV determined from the upper extremity pulse wave velocity hbPWV. In addition, in drawing 4, pulse wave velocity PWV depends the thing with the membrum-inferius pulse wave velocity baPWV quicker than the upper extremity pulse wave velocity hbPWV on becoming quick in inverse proportion to 1/square of the diameter of a blood vessel, and the ankle of the diameter of a blood vessel being thinner than an overarm.

[0035] In the process in which the cuff 20 for overarms is made to carry out **** pressure lowering of the overarm blood-pressure value decision means 72 by the cuff pressure control means 60 The oscillometric method which was easy to be based on change of the amplitude of the overarm pulse waves WAR and WAL which the pulse wave signals SMA or SMB by which sequential extraction is carried out express, and was known is used. the right upper arm highest-blood-pressure value BPASYS which is the blood-pressure value BP of right upper arm 14R -- (R), right upper arm lowest-blood-pressure value BPADIA (R), and the right upper arm mean-blood-pressure value BPAMEAN (R) -- (L), left upper arm lowest-blood-pressure value BPADIA(L), and the left upper arm mean-blood-pressure value BPAMEAN (L) are determined. and the left upper arm highest-blood-pressure value BPASYS which is the blood-pressure value BP in left upper arm 14L -- The determined right upper arm highest-blood-pressure value BPASYS (R) left upper arm highest-blood-pressure value BPASYS (L) is displayed on a drop 54.

[0036] The difference value calculation means 74 computes the difference value of the pulse-wave-velocity information on a left lower extremity and the pulse-wave-velocity information on a right lower extremity which were computed by the membrum-inferius pulse-wave-velocity information calculation means 68, the difference value of the rise description value of a left lower extremity and the rise description value of a right lower extremity which were determined by the rise description value decision means 62, and the difference value of the acutance of image of a left lower extremity and the acutance of image of a right lower extremity which were computed by the acutance-of-image calculation means 64. The above-mentioned difference value is a value which shows how much constriction related pulse wave information, such as pulse-wave-velocity information, differs by right and left, for example, is a difference or a ratio on either side etc.

[0037] It judges with the preliminary judging means 76 having the misgiving of a constriction in an artery of lower extremity based on being the value of abnormality within the limits set up as range where the membrum-inferius pulse-wave-velocity information computed, respectively by the membrum-inferius pulse-wave-velocity information calculation means 68 which is a constriction related pulse-wave information decision means, the rise description value decision means 62, and the acutance-of-image calculation means 64, the rise description value, and acutance of image have the misgiving of a constriction about each.

[0038] The abnormality range of the above-mentioned membrum-inferius pulse-wave-velocity information is range outside the normal range determined with said normal-range decision means 70. Moreover, the abnormality range of the rise description value and the abnormality range of acutance of image are beforehand determined based on the experiment. When U-time is computed as a rise description value, the abnormality range is set as 180 or more msec, and when %MAP is computed as acutance of image, the abnormality range is set up to 42% or less. Moreover, when at least one of three of the above-mentioned membrum-inferius pulse-wave-velocity information, the rise description value, and acutance of image is the abnormality range, you may judge with the misgiving of a constriction being in an artery of lower extremity, and when any two are the abnormality range, or when all three are the abnormality range, you may judge with the misgiving of a constriction being in an artery of lower extremity. In addition, since membrum-inferius pulse-wave-velocity information, the rise description value, and acutance of image are determined about the membrum inferius on either side, respectively, the

misgiving of the constriction of an artery of lower extremity can be judged about each membrum inferius on either side.

[0039] It judges with the preliminary judging means 76 having the misgiving of a constriction in an artery of lower extremity based on being beyond the reference value with which the membrum-inferius pulse-wave-velocity information computed with said difference value calculation means 72, the rise description value, and the difference value of acutance of image were set up further beforehand. A difference value turns into beyond a reference value because it thinks because a constriction is in either of the membrum inferius on either side. in addition -- the case where it judges with the misgiving of a constriction being in an artery of lower extremity based on a difference value -- right and left -- whether the misgiving of a constriction is in which membrum inferius cannot judge.

[0040] It judges whether the preliminary judging means 76 is smaller than the minimum value (for example, 100mmHg(s)) to which no above-mentioned membrum-inferius pulse-wave-velocity information, rise description values, and acutance of image were abnormality range, and the overarm highest-blood-pressure value BPASYS further determined by the overarm blood-pressure value decision means 72 was beforehand set when said difference value was smaller than a reference value. Thus, it is because it is difficult to diagnose the constriction of an artery of lower extremity even if judging whether the overarm highest-blood-pressure value BPASYS is smaller than the minimum value set up beforehand computes ABI, when the overarm highest-blood-pressure value BPASYS is smaller than the minimum value set up beforehand, a constriction is in an upper extremity, the overarm highest-blood-pressure value BPASYS may be falling and there is a constriction also in an upper extremity.

[0041] When it is the case where it is judged with an ABI measurement starting means 78 to function as a blood-pressure-measurement starting means having the misgiving of a constriction in an artery of lower extremity with the preliminary judging means 76 and the overarm highest-blood-pressure value BPASYS is said more than minimum value, the overarm blood-pressure value decision means 72 and an ankle blood-pressure value decision means 82 to mention later are performed. In addition, when there is misgiving of a constriction only in one membrum inferius, blood pressure measurement is performed only about the ankle 12 of the side which has the misgiving of a constriction with the ankle blood-pressure value decision means 82. Moreover, although was beforehand set up also about the overarm blood pressure measurement by the overarm blood-pressure value decision means 72 and blood pressure measurement may be performed only about an overarm 14, blood pressure measurement is preferably performed about the overarm 14 of both sides.

[0042] It is the case where it is judged with the membrum-inferius blood-pressure-measurement starting means 80 having the misgiving of a constriction in an artery of lower extremity with the preliminary judging means 76, and when the overarm blood-pressure value BPASYS is smaller than said minimum value, the ankle blood-pressure value decision means 82 is performed. Since it is difficult to diagnose the constriction of an artery of lower extremity from ABI when the overarm blood-pressure value BPASYS is smaller than said minimum value, it is for diagnosing the constriction of an artery of lower extremity only with the absolute value of the ankle blood-pressure value BQL.

[0043] It is a functional block diagram explaining the important section of the function performed when judged with drawing 5 having the misgiving of a constriction in an artery of lower extremity by performing the function shown in drawing 2 among the control functions of an arithmetic sequence unit 38.

[0044] The ankle blood-pressure value decision means 82 is performed by the ABI measurement starting means 78 or the membrum-inferius blood-pressure-measurement starting means 80. In the process which make control the compression pressure force of the cuff 18 for ankles wound around the ankle 12 of the membrum inferius of a certain one side of the misgiving of a constriction, or both by the cuff pressure control means 60, and the compression pressure force of the cuff 18 for ankles is made to carry out **** pressure lowering The oscillometric method which was easy to be based on change of the amplitude of the membrum-inferius pulse waves WLR and WLL which the pulse wave signals SMC or SMd by which sequential extraction is carried out express, and was known is used. The right leg neck highest-blood-pressure value BPLSYS (R) which is the blood-pressure value BP in right leg neck 12R, right leg neck lowest-blood-pressure value BPLDIA(R) and a right leg neck mean-blood-pressure value BPLMEAN (R) And the left leg neck highest-blood-pressure value BPLSYS (L) which is the blood-pressure value BP in left leg neck 12L, and left leg neck lowest-blood-pressure value BPLDIA(L) and a left leg neck mean-blood-pressure value BPLMEAN (L) are determined. The determined right leg neck highest-blood-pressure value BPLSYS(R) left leg neck highest-blood-pressure value BPLSYS (L) is displayed on a drop 54.

[0045] An ankle overarm blood-pressure characteristic calculation means 84 to function as a membrum-inferius upper extremity blood-pressure characteristic calculation means The right leg neck blood-pressure value blood-pressure value BQL (R) (for example, the right leg neck highest-blood-pressure value BPLSYS (R)) determined by the ankle blood-pressure value decision means 82, or the left leg neck blood-pressure value BQL (L) (for example, the left leg neck highest-blood-pressure value BPLSYS (L)) By breaking by the overarm blood-pressure value BPA (for example, the overarm highest-blood-pressure value BPASYS being equivalent to the ankle highest-blood-pressure value BPLSYS) corresponding to the above-mentioned ankle blood-pressure value BQL among the overarm blood-pressure values BPA determined by the overarm blood-pressure value decision means 72 A right leg neck overarm blood-pressure characteristic (= ABIR) or a left leg neck overarm blood-pressure characteristic (= ABIL) is computed. And the value of the computed ABIR and ABIL is displayed on a drop 54.

[0046] Since the right leg neck blood-pressure value BQL (R) and the left leg neck blood-pressure value BQL (L) fall when there is a constriction of an artery of lower extremity, as for these ABIR(s) and ABIL, the constriction of an artery of lower extremity falls to a case. Therefore, when ABIR and ABIL are smaller than a reference value (for example, 0.9), it can be judged that the misgiving to which a constriction is in an artery of lower extremity is strong. In addition, any shall be used as an overarm blood-pressure value BPA in calculation of ABI between the right upper arm blood-pressure value BQL (L) and the left upper arm blood-pressure value BPA (L) uses the value of the higher one preferably, although it may be beforehand determined in advance of blood pressure measurement. It is because ABI will become small if the value of the higher one is used, so it becomes easy to discover the constriction of an artery of lower extremity based on ABI.

[0047] Drawing 6 thru/or drawing 9 are the flow charts for explaining still more concretely the important section of the control function of the arithmetic sequence unit 38 shown in drawing 2 and drawing 5 , drawing 6 is a signal reading routine which reads the signal for a preliminary judging, drawing 7 is a preliminary judging routine which performs a preliminary judging based on the read signal, drawing 8 is an ABI measurement routine, and drawing 9 is an ankle blood-pressure-measurement routine.

[0048] First, the signal reading routine of drawing 6 is explained. At the step (a step is skipped hereafter) SA 1 of drawing 6 When body of blood-pressure-measurement equipment 24a, pressure regulating valve 26a with which b, c, and d are equipped, respectively, and b, c and d are made into a pressure supply condition and an air pump 36 drives The pressure up of the cuffs 18R and 18L for ankles and the cuffs 20R and 20L for overarms is started, and it is judged in continuing SA2 whether cuff pressure PC of four cuffs 18R, 18L, 20R, and 20L was set to 60 or more mmHgs set up as pulse wave *****. When decision of this SA2 is denied, decision of SA2 is repeated.

[0049] And if decision of the above SA 2 is affirmed by rise of cuff pressure PC, in continuing SA3, cuff pressure PC will be maintained by suspending an air pump 36 and changing a pressure regulating valve 26 to a pressure maintenance condition. The above [SA / SA and / 3] 1 is equivalent to the cuff pressure control means 60.

[0050] In continuing SA4, the cardiac correspondence number SH supplied from the pulse wave signals SMb, SMc, and SMd and the heartbeat microphone 44 which are supplied from body of blood-pressure-measurement equipment 24b, pulse wave discriminator 32b with which c and d are equipped, respectively, and c and d is read by one beat.

[0051] Then, SA5 thru/or SA8 equivalent to the cuff pressure control means 60 is performed. SA5 -- a pressure regulating valve 26 -- c and d are changed to a rapid exhaust-gas-pressure condition -- the cuff 18 for ankles -- when the cuff pressures PCc and PCd of R and L are released, and pressure regulating valves 26a and 26b are again switched to a pressure supply condition in continuing SA6 and an air pump 36 drives again, the rapid pressure up of the cuffs 20R and 20L for overarms is started. In continuing SA7, it is judged whether it became more than the target [for the cuff pressures PCa and PCb of the cuffs 20R and 20L for overarms to have been set as 180mmHg(s), respectively] compression pressure PCM. When decision of this SA7 is denied, the rise of cuff pressures PCa and PCb is continued by performing six or less above SA repeatedly.

[0052] And if decision of the above SA 7 is affirmed by the rise of cuff pressures PCa and PCb, at continuing SA8, an air pump 36 will be suspended, and pressure regulating valves 26a and 26b will be switched to a *** exhaust-gas-pressure condition, and it will be dropped at the loose rate which is 5 mmHg/sec extent as which the pressure in cuff 20for overarms R and 20L was determined beforehand.

[0053] Next, the blood-pressure value decision routine of SA9 equivalent to the overarm blood-pressure value decision means 72 is performed. That is, the amplitude of the overarm pulse waves WAR and WAL which the pulse wave signals SMa and SMb serially supplied from the pulse wave discriminators 32a and

32b express is determined for every beat, and the right upper arm highest-blood-pressure value BPASYS (R), the left upper arm neck highest-blood-pressure value BPASYS (L), etc. are determined according to the blood-pressure value decision algorithm of an oscillograph metric method known well based on change of the amplitude.

[0054] Then, in SA10 equivalent to the cuff pressure control means 60, by switching two pressure regulating valves 26a and 26b to a rapid exhaust-gas-pressure condition, the inside of cuff 20 for overarms R and 20L is made to carry out exhaust gas pressure quickly, and a signal reading routine is terminated.

[0055] After a signal reading routine is terminated, the preliminary judging routine of drawing 7 is performed continuously. In drawing 7, SB1 which is equivalent to the upper extremity pulse-wave-velocity information calculation means 66 first is performed. While the start point of I sound of a heartbeat is determined in SB1 based on the cardiac correspondence number SH read by SA4 of drawing 6. The standup point of the left upper arm pulse wave WAL which the pulse wave signal SMb expresses based on the pulse wave signal SMb read by the SA4 is determined. The time difference hbDT of the start point of I sound and the standup point of the left upper arm pulse wave WAL, i.e., the upper extremity pulse wave propagation time, is computed, and the upper extremity pulse wave velocity hbPWV is further computed by the upper extremity pulse wave propagation time HbDT being substituted for said formula 1.

[0056] Then, SB2 equivalent to the normal-range decision means 70 is performed. In SB2, based on the upper extremity pulse wave velocity hbPWV computed by the above SB1, the membrum-inferius pulse wave velocity baPWV is determined from the relation of above-mentioned drawing 4, and -10% to +10% of range of the determined membrum-inferius pulse wave velocity baPWV is determined as the normal range of the membrum-inferius pulse wave velocity hbPWV.

[0057] Then, the right lower extremity pulse wave velocity baPWV (R) and the left lower extremity pulse wave velocity baPWV (L) are computed by SB3 equivalent to the membrum-inferius pulse-wave-velocity information calculation means 68 being performed. Namely, the standup point of the right leg neck pulse wave WLR which the pulse wave signals SMC and SMd express based on the pulse wave signals SMC and SMd read by SA4 of drawing 6, respectively, and the left leg neck pulse wave WLL is determined, respectively. Then, the time difference (R) baDT, i.e., the right lower extremity pulse wave propagation time, of the standup point of the left upper arm pulse wave WAL and the standup point of the above-mentioned right leg neck pulse wave WLR which were determined by said SB1 And the time difference (L) baDT of the standup point of the left upper arm pulse wave WAL and the standup point of the above-mentioned left leg neck pulse wave WLL which were determined by said SB1, i.e., the left lower extremity pulse wave propagation time, is computed. Furthermore, the right lower extremity pulse wave velocity baPWV (R) and the left lower extremity pulse wave velocity baPWV (L) are computed by these right lower extremity pulse wave propagation time baDT (R) and the left lower extremity pulse wave propagation time baDT (L) being substituted for said formula 2. Moreover, the computed right lower extremity pulse wave velocity baPWV (R) and the left lower extremity pulse wave velocity baPWV (L) are displayed on a drop 54.

[0058] Then, SB4 equivalent to the rise description value decision means 62 is performed. The standup point and peak of the right leg neck pulse wave WLR which the pulse wave signals SMC and SMd express with SB4 based on the pulse wave signals SMC and SMd read by SA4 of drawing 6, respectively, and the left leg neck pulse wave WLL are determined. It starts with the peak of the right leg neck pulse wave WLR, and time difference with a point is computed as U-time (R), it starts with the peak of the left leg neck pulse wave WLL, and time difference with a point is computed as U-time (L). Moreover, U-time (R) and U-time (R) which were computed are displayed on a drop 54.

[0059] Then, SB5 equivalent to the acutance-of-image calculation means 64 is performed. While %MAP (R) is computed by breaking the area S by the product (WxH) of peak height H and the pulse period W about the right leg neck pulse wave WLR which the pulse wave signal SMC read by SA4 of drawing 6 expresses with SB5 About the left leg neck pulse wave WLL which the pulse wave signal SMd read by SA4 of drawing 6 expresses, %MAP (L) is computed by breaking the area S by the product (WxH) of peak height H and the pulse period W. Moreover, %MAP (R) and %MAP (L) which were computed are displayed on a drop 54.

[0060] In continuing SB6, it is judged whether it is in abnormality within the limits to which U-time (R) and U-time (L) which were computed by the right lower extremity pulse wave velocity baPWV (R) computed by said SB3, the left lower extremity pulse wave velocity baPWV (L), and said SB4, %MAP (R) computed by the above SB5, and %MAP (L) were beforehand set about each. That is, about the right lower extremity pulse wave velocity baPWV (R) and the left lower extremity pulse wave velocity baPWV

(L), it is judged whether it is outside the normal range determined by said SB2, it is judged about U-time (R) and U-time (L) whether they are 180 or more msec, and it is judged [MAP / % / %MAP (R) and / (L)] whether it is 42% or less. And when at least one of them is in abnormality within the limits, decision of SB6 is affirmed. Since it is suspected that a constriction is in an artery of lower extremity when decision of this SB6 is affirmed, the ABI measurement routine of drawing 8 is performed. On the other hand, when decision of SB6 is denied, SB7 equivalent to the difference value calculation means 74 is performed.

[0061] Pulse-wave-velocity difference (absolute value) deltaPWV of the right lower extremity pulse wave velocity baPWV (R) and the left lower extremity pulse wave velocity baPWV (L) which were computed by said SB3 in SB7, Difference delta%MAP (absolute value) of difference deltaU-time (absolute value) of U-time (R) and U-time (L) which were computed by said SB4, and %MAP (R) and %MAP (L) computed by said SB5 is computed as a difference value.

[0062] deltaPWV computed by the above SB 7 in continuing SB8, deltaU-time, It is judged whether delta%MAP is beyond the reference value beforehand set up about each. And these deltaPWV, deltaU-time, When at least one of delta%MAP is beyond a reference value, decision of SB8 is affirmed. Since the misgiving of a constriction is in the artery of lower extremity of one of membrum inferius when decision of this SB8 is affirmed, the ABI measurement routine of drawing 8 is performed and ABI of both membrum inferius is measured. Thus, since an ABI measurement routine is performed when decision of SB6 or SB8 is affirmed, SB6 and SB8 are equivalent to the ABI measurement starting means 78.

[0063] On the other hand, when decision of SB8 is denied, SB9 is performed continuously. In SB9, it is judged whether the overarm highest-blood-pressure value BPASYS determined by SA9 of drawing 6 is smaller than 100mmHg(s) beforehand set up as the minimum value. When this decision is affirmed, the ankle blood-pressure-measurement routine of drawing 9 is performed. Therefore, SB9 is equivalent to the membrum-inferius blood-pressure-measurement starting means 80. On the other hand, when decision of SB9 is denied, this routine is terminated, without judging that there is no misgiving of a constriction in an artery of lower extremity, and also performing an ABI measurement routine and ankle blood-pressure-measurement routine. Thus, since it is judged whether the misgiving of a constriction is in an artery of lower extremity by SB6, SB8, and SB9, SB6, SB8, and SB9 are equivalent also to the preliminary judging means 76.

[0064] Then, the ABI measurement routine of drawing 8 is explained. By the ABI measurement routine of drawing 8 , SC1 thru/or SC3 equivalent to the cuff pressure control means 60 is performed first. The pressure regulating valves 26a and 26b connected to two cuffs 20R and 20L for overarms in SC1, respectively, And the pressure regulating valves 26c or 26d connected to the cuff 18 (it is the cuff 18 for ankles of both sides when judged with there being misgiving of a constriction in SB8) for ankles of the side judged as there being misgiving of a constriction by SB6 or SB8 of drawing 7 are switched to a pressure supply condition. And when an air pump 36 drives, the rapid pressure up of two cuffs 20R and 20L for overarms and one [at least] cuff 18 for ankles is started. In continuing SC2, it is judged about each cuff pressure PC whether it became more than the target compression pressure PCM (about 180mmHg(s) and the cuff 18 for ankles, they are [cuff / 20 / for overarms] 240mmHg(s)) to which cuff pressure PC of those cuffs 18 and 20 was set beforehand, respectively. When decision of this SC2 is denied, a rise of cuff pressure PC is continued by performing one or less above SC repeatedly.

[0065] And if decision of the above SC 2 is affirmed by rise of cuff pressure PC, at continuing SC3, it will change to a **** exhaust-gas-pressure condition sequentially from the pressure regulating valve 26 connected to the cuffs 18 and 20 which reached the target compression pressure PCM, and will be dropped at the cuff 18 connected to the pressure regulating valve 26, and the loose rate which is 5 mmHg/sec extent as which the pressure in 20 was determined beforehand. And if decision of SC2 is affirmed about all cuff pressure PCs, an air pump 36 will also be suspended.

[0066] Next, the blood-pressure value decision routine of SC4 equivalent to the overarm blood-pressure value decision means 72 and the ankle blood-pressure value decision means 82 is performed. That is, the amplitude of the overarm pulse wave WA which the pulse wave signal SM serially supplied from the pulse wave discriminator 32 expresses, or the ankle pulse wave WL is determined for every beat, and the right upper arm highest-blood-pressure value BPASYS(R) left upper arm highest-blood-pressure value BPASYS (L), the right (left) ankle highest-blood-pressure value BPLSYS, etc. are determined according to the blood-pressure value decision algorithm of an oscillograph metric method known well based on change of the amplitude.

[0067] Next, the inside of a cuff 18 and 20 is made to carry out exhaust gas pressure quickly in SC5 equivalent to the cuff pressure control means 60 by switching the pressure regulating valve 26 which

suit the **** exhaust-gas-pressure condition to a rapid exhaust-gas-pressure condition.

[0068] Then, SC6 equivalent to the ankle overarm blood-pressure characteristic calculation means 84 is performed. In SC6, by being broken by the value of the higher one of the right upper arm highest-blood-pressure value BPASYS (R) as which the right leg neck highest-blood-pressure value BPLSYS (R) determined by SC4 or the left leg neck highest-blood-pressure value BPLSYS (L) was determined by SC4, and the left upper arm highest-blood-pressure values BPASYS (L), ABIR or ABIL is computed and the computed ABIR or ABIL is displayed on a drop 54.

[0069] Then, the ankle blood-pressure-measurement routine of drawing 9 is explained. By the ankle blood-pressure-measurement routine of drawing 9, SD1 thru/SD3 equivalent to the cuff pressure control means 60 is performed first. In SD1, when the pressure regulating valves 26c or 26d connected to the cuff 18 for ankles of the side judged as there being misgiving of a constriction by SB9 of drawing 7 are switched to a pressure supply condition and an air pump 36 drives, the rapid pressure up of one [at least] cuff 18 for ankles is started. In continuing SD2, it is judged whether it became more than the target compression pressure PCM (for example, 240mmHg(s)) to which cuff pressure PC of the cuff 18 was set beforehand. When decision of this SD2 is denied, a rise of cuff pressure PC is continued by performing one or less above SD repeatedly.

[0070] And if decision of the above SD 2 is affirmed by rise of cuff pressure PC, at continuing SD3, while an air pump 36 is stopped, a pressure regulating valve 26 will be changed to a **** exhaust-gas-pressure condition, and it will be dropped at the loose rate which is 5 mmHg/sec extent as which the pressure in a cuff 18 was determined beforehand.

[0071] Next, the blood-pressure value decision routine of SD4 equivalent to the ankle blood-pressure value decision means 82 is performed. That is, the amplitude of the ankle pulse wave WL which the pulse wave signal SM serially supplied from the pulse wave discriminator 32 expresses is determined for every beat, and the right (left) ankle highest-blood-pressure value BPLSYS, the right (left) ankle lowest-blood-pressure value BPLDIA, and the right (left) ankle mean-blood-pressure value BPLMEAN are determined according to the blood-pressure value decision algorithm of an oscillograph metric method known well based on change of the amplitude.

[0072] Next, the inside of a cuff 18 is made to carry out exhaust gas pressure quickly by switching a pressure regulating valve 26 to a rapid exhaust-gas-pressure condition in SD5 equivalent to the cuff pressure control means 60.

[0073] In continuing SD6, the right (left) ankle highest-blood-pressure value BPLSYS determined by SD4 is displayed on a drop 54.

[0074] In the example based on an above-mentioned flow chart, it sets in advance of measurement of the ankle blood-pressure value BQL by ankle blood-pressure-measurement equipment 42 to SB3, SB4, and SB5 (constriction related pulse wave information decision means). The membrum-inferius pulse wave velocity baPWV, U-time, and %MAP are determined from the ankle pulse wave WL extracted by the pulse wave discriminators 32c and 32d. And since these membrum-inferius pulse wave velocity baPWV, U-time, and %MAP are displayed on a drop 54 In order to compute ABI, it becomes unnecessary to perform blood pressure measurement by ankle blood-pressure-measurement equipment 42, when it can be judged from these membrum-inferius pulse wave velocity baPWV, U-time, and %MAP that there is no misgiving of the constriction of an artery of lower extremity. Therefore, the pain of the patient at the time of diagnosing the constriction of an artery of lower extremity decreases.

[0075] Moreover, in the example based on an above-mentioned flow chart, when judged with there being misgiving of a constriction by SB6 and SB9 (preliminary judging means 76), blood pressure measurement by ankle blood-pressure-measurement equipment 42 and overarm blood-pressure-measurement equipment 40 is performed automatically, and there is an advantage by which ABI is computed.

[0076] Moreover, in the example based on an above-mentioned flow chart, the normal range of the membrum-inferius pulse wave velocity baPWV is determined from the relation of drawing 4 in SB2 (normal-range decision means 70) based on the upper extremity pulse wave velocity hbPWV. And in SB6 (preliminary judging means 76), it is judged with the misgiving of a constriction being in an artery of lower extremity based on the membrum-inferius pulse wave velocity baPWV computed in SB3 (membrum-inferius pulse-wave-velocity information calculation means 68) being outside a normal range. Since the above-mentioned normal range is determined based on the upper extremity pulse wave velocity hbPWV actually measured for every measurement, as compared with the case where the misgiving of the constriction of an artery of lower extremity is judged based on whether it is actually in the general normal range set up so that the measured membrum-inferius pulse wave velocity baPWV might be applied to many patients, preliminary decision of the existence of the constriction in an artery of lower extremity can

perform it with a more sufficient precision.

[0077] moreover, in the example based on an above-mentioned flow chart The left lower extremity pulse wave velocity baPWV (L), U-time (L) based on the left lower extremity pulse wave WLL, % The right lower extremity pulse wave velocity baPWV based on MAP (L) and the right lower extremity pulse wave WLR (R) When at least one of the difference values (deltaPWV, deltaU-time, delta%MAP) with U-time (R) and %MAP (R) is beyond a reference value In SB8 (preliminary judging means 76), since it is judged with there being misgiving of a constriction, preliminary decision of the existence of the constriction in an artery of lower extremity can carry out with a more sufficient precision.

[0078] As mentioned above, although one example of this invention was explained based on the drawing, this invention is applied also in other modes.

[0079] For example, although the abnormality range of the membrum-inferius pulse wave velocity baPWV was determined for every patient with the operation gestalt mentioned above by deciding that they will be range other than the normal range determined by the normal-range decision means 70, the abnormality range of the membrum-inferius pulse wave velocity baPWV may be the constant value set up beforehand. On the contrary, with the operation gestalt mentioned above, although the abnormality range of U-time and %MAP was determined beforehand, it may determine the abnormality range of U-time in the membrum inferius, or %MAP for every patient based on U-time and %MAP which measured U-time or %MAP in the overarm, and were measured in the overarm like [in the case of the membrum-inferius pulse wave velocity baPWV].

[0080] Moreover, when the preliminary judging means 76 had the misgiving of a constriction in an artery of lower extremity with the operation gestalt mentioned above, blood pressure measurement by ankle blood-pressure-measurement equipment 42 and/or overarm blood-pressure-measurement equipment 40 was performed automatically, but when judged with the misgiving of a constriction being in an artery of lower extremity, it is good to even display the alphabetic character or notation which only shows that on a drop 54. Moreover, since it can judge whether an operator needs to measure a membrum-inferius upper extremity blood-pressure characteristic from the contents of a display like the example based on the above-mentioned flow chart when constriction related pulse wave information (baPWV, U-time, %MAP) is displayed on a drop 54, the preliminary judging means 76 does not need to be established in that case.

[0081] Moreover, independently [the pulse wave discriminator 32 of these blood-pressure-measurement equipments 40 and 42], although the pulse wave discriminator 32 with which overarm blood-pressure-measurement equipment 40 was equipped functioned also as upper extremity pulse wave detection equipment and the pulse wave discriminator 32 with which ankle blood-pressure-measurement equipment 42 was equipped was functioning also as membrum-inferius pulse wave detection equipment with the operation gestalt mentioned above, only in order to detect a pulse wave, an upper extremity or the membrum inferius may be equipped with pulse wave detection equipment. The photoelectrical pulse wave sensor with which the finger tip section etc. is equipped for the impedance pulse wave sensor which detects impedances which press predetermined arteries, such as a photoelectrical pulse wave detection probe for oxymetries and a radial artery, from epidermis, and detect a pressure pulse wave as pulse wave detection equipment, for example, such as a pressure pulse wave sensor of a format, an arm, and a fingertip, through an electrode, pulse detection, etc. can be used.

[0082] Moreover, although the operation gestalt mentioned above explained the example which computes the overarm pulse-wave-velocity information between the heartbeat microphone 44 and the cuff 20 for overarms, the overarm pulse-wave-velocity information between other 2 parts may be computed. For example, since the heart is not located on a living body center line, the cuffs 20 for overarms wound around the overarm 14 on either side differ in the distance from the heart. Then, overarm pulse-wave-velocity information may be computed from the time difference of the overarm pulse waves WAR and WAL generated in the cuff 20 for overarms on either side. Or the finger tip section of an arm may be equipped with a photoelectrical pulse wave sensor, and overarm pulse-wave-velocity information may be computed between the heart (or overarm) and a fingertip.

[0083] Moreover, although the operation gestalt mentioned above explained the example which computes membrum-inferius pulse-wave-velocity information between the cuff 18 for ankles, and the cuff 20 for overarms, the membrum-inferius pulse-wave-velocity information between the heartbeat microphone 44 and the cuff 18 for ankles may be computed.

[0084] As mentioned above, although the operation gestalt of this invention was explained to the detail based on the drawing, this is 1 operation gestalt to the last, and this invention can be carried out in the mode which added various modification and amelioration based on this contractor's knowledge.

[Translation done.]

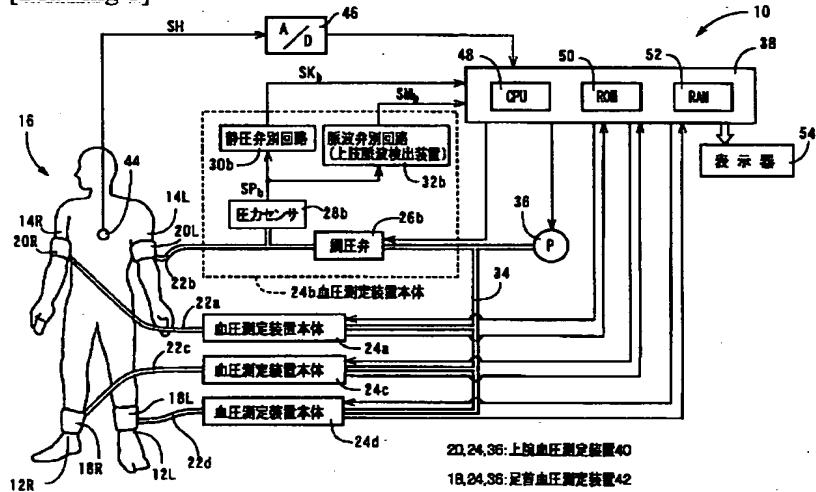
*** NOTICES ***

JPO and NCIPPI are not responsible for any damages caused by the use of this translation.

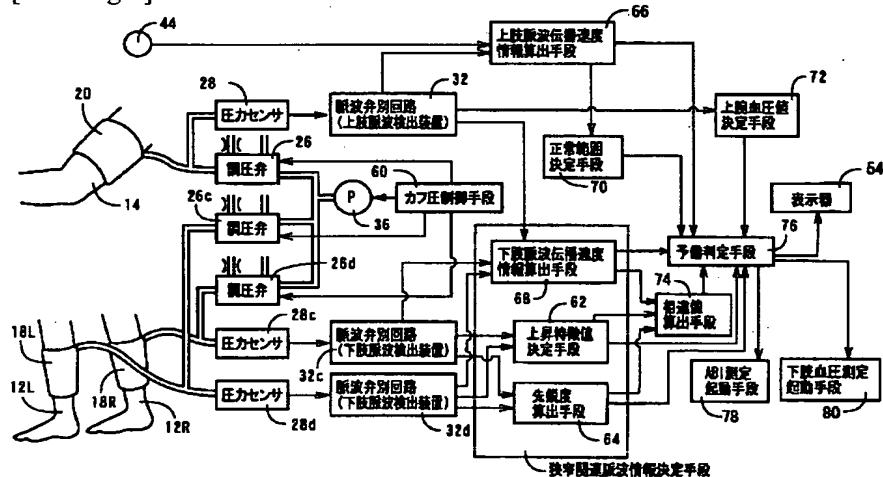
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

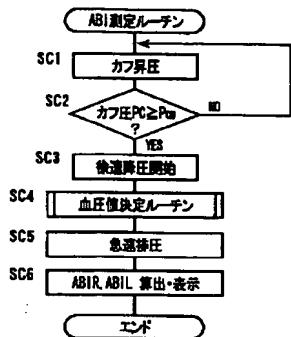
[Drawing 1]



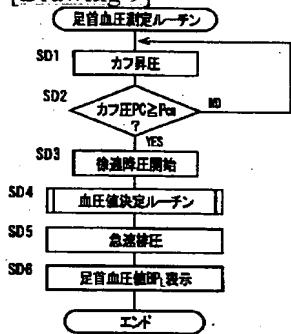
[Drawing 2]



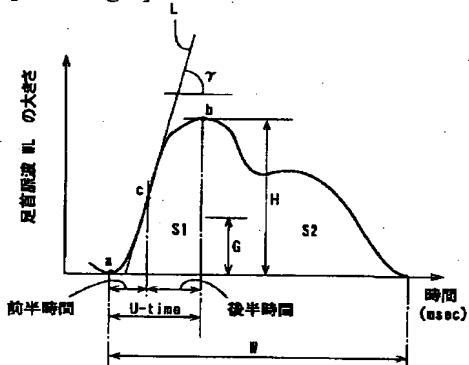
[Drawing 8]



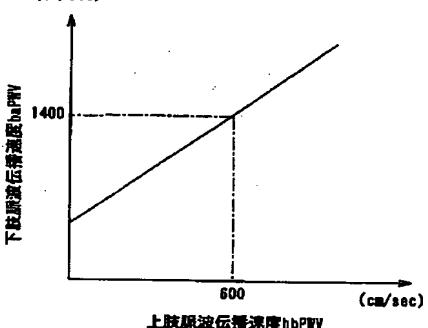
[Drawing 9]



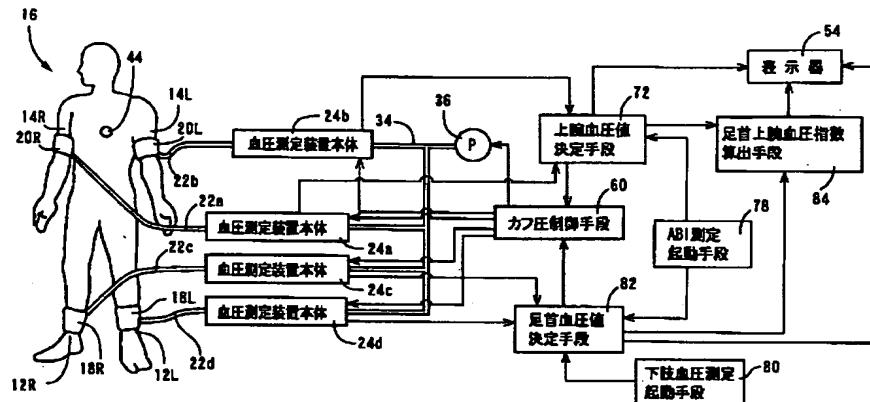
[Drawing 3]



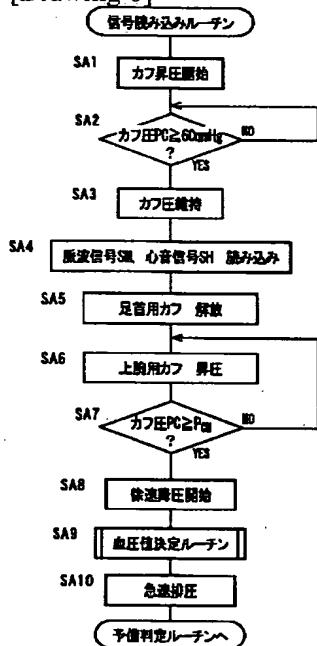
[Drawing 4]



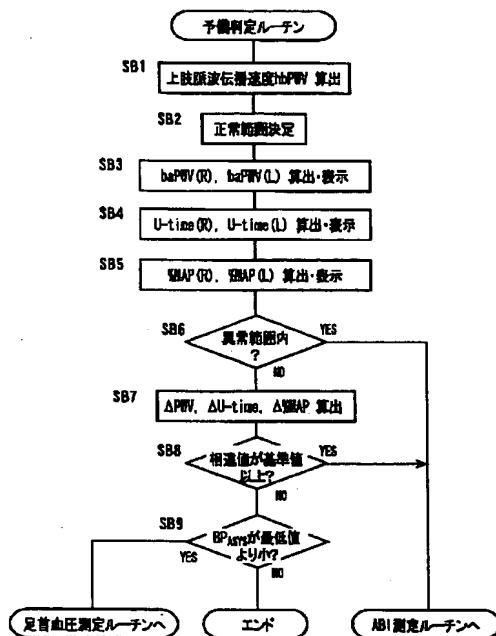
[Drawing 5]



[Drawing 6]



[Drawing 7]



[Translation done.]